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FEBRUARY 1957

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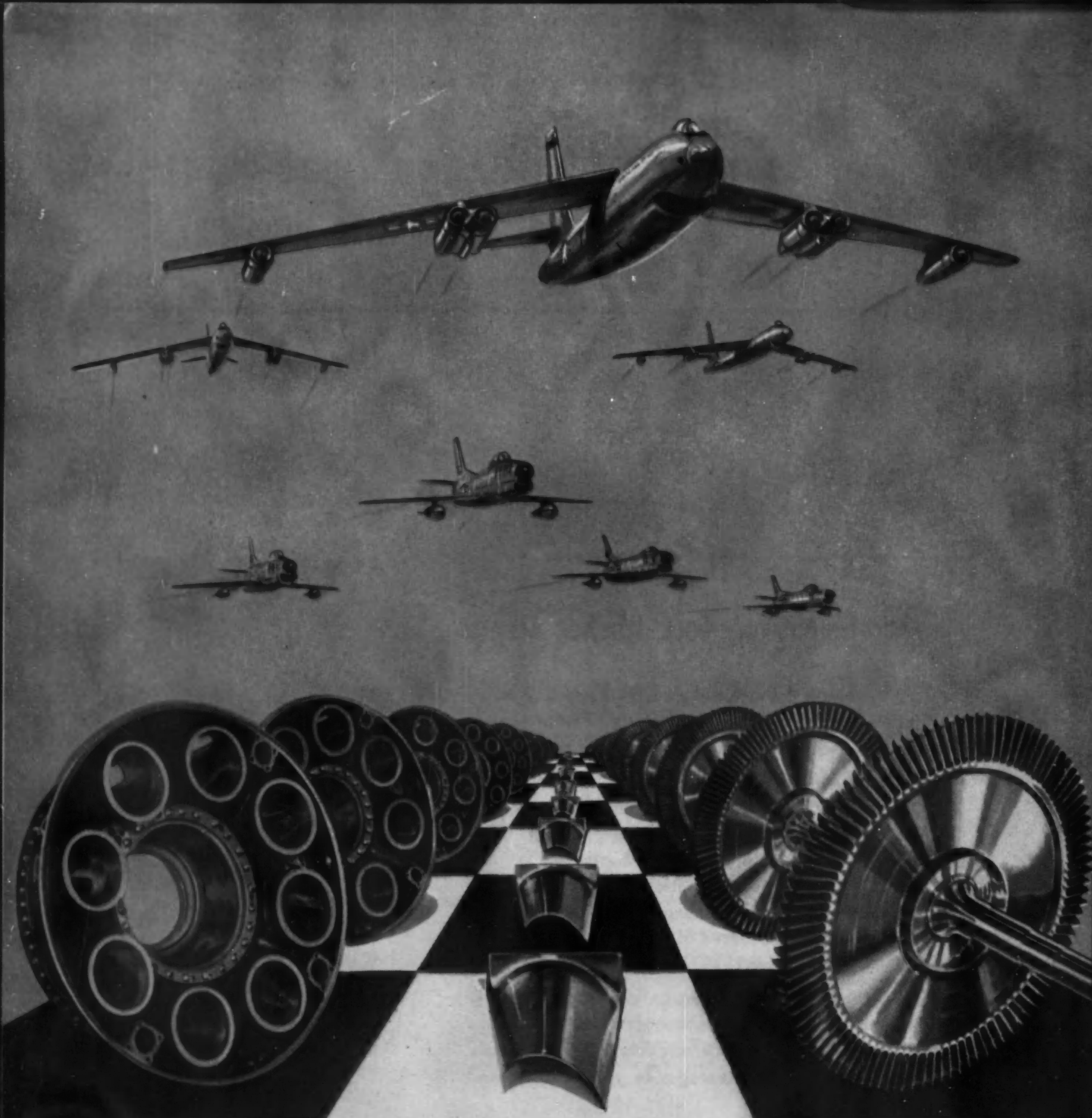

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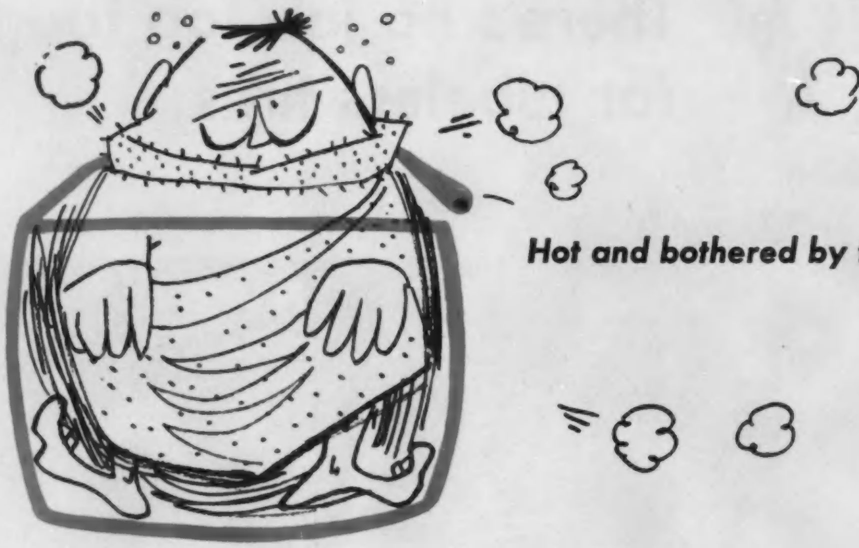

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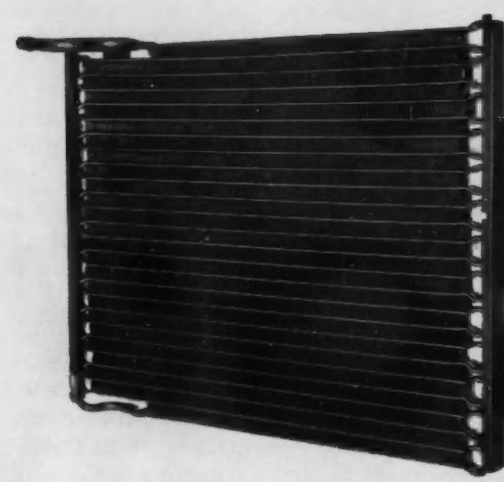

GM STEEL TUBING BY ROCHESTER PRODUCTS

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This Forward Control truck innovation puts a 74" pickup box on an 81" wheelbase—a record-breaking cargo space per inch of wheelbase!

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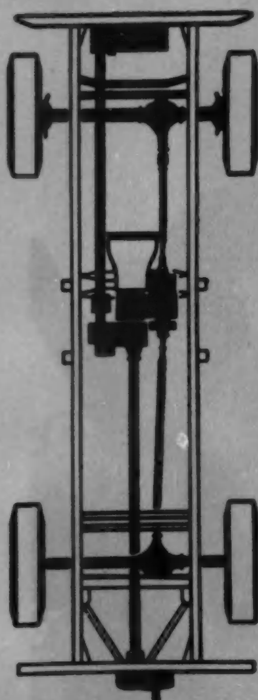
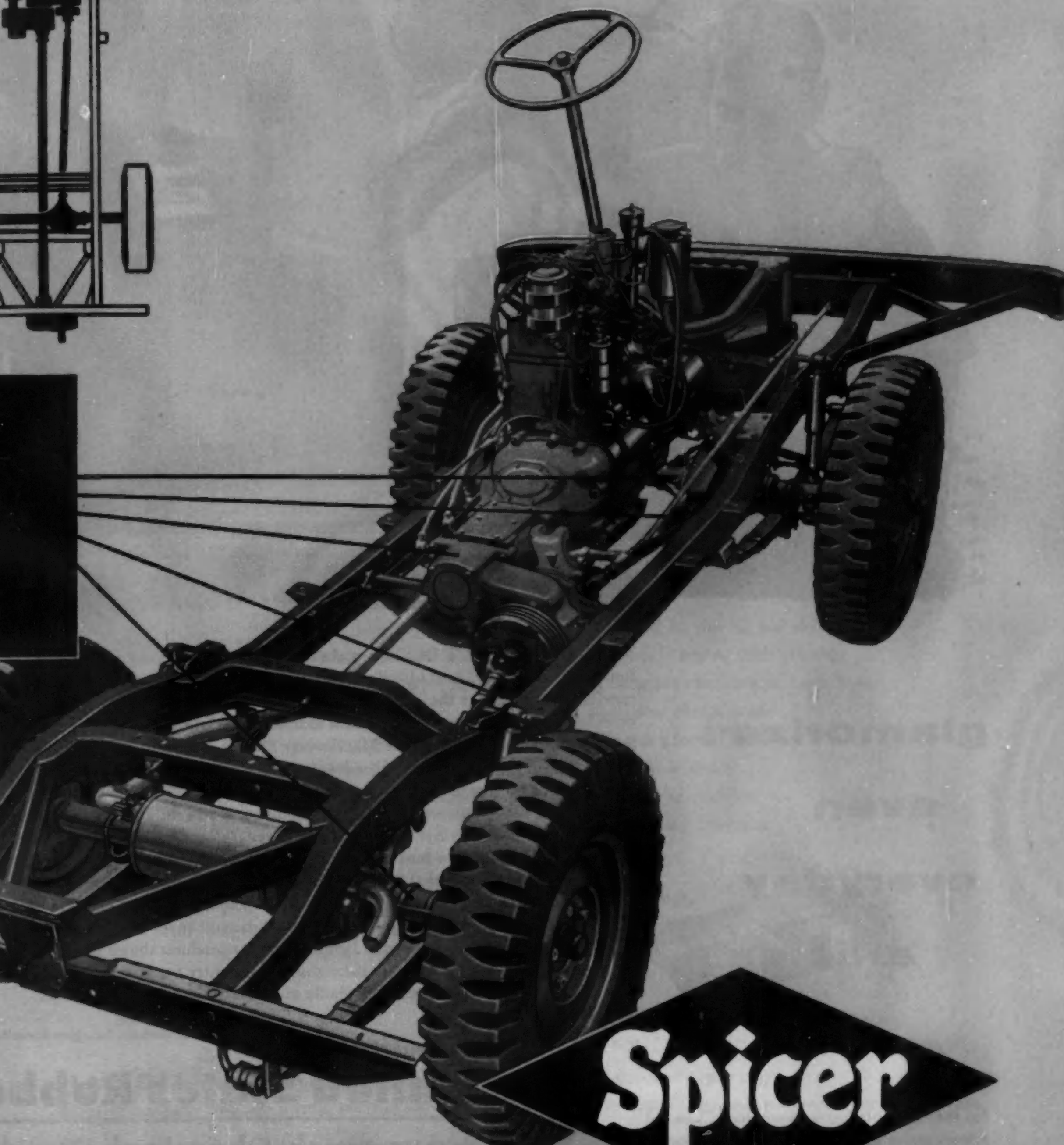


Diagrammatic view of the new Willys Forward Control Jeep FC-150 showing the Spicer 4-Wheel-Drive Assembly, including axles, joints, shafts, transfer case; and front, center and rear Power Take-Off points.



Naugatuck MARVIBOND

Marvinol vinyl-to-metal laminating process

glamorizes even everyday articles

MODERN PRODUCT DESIGN seeks to combine eye-catching beauty with functional durability. And Marvibonded vinyl-to-metal laminates do just that! Two excellent examples are the "Thunderbird" ice chest and picnic jug, manufactured by Poloron Products, Inc.* Their almost indestructible fabric-embossed vinyl finish is fused to aluminum sheets by the Marvibond† Process, then formed into the shells of extremely lightweight, glass-fiber-insulated food and drink containers that are as eye-appealing as they are practical.

Marvibonded laminates enable manufacturers to add the colorful beauty, texture and wear-resistance of vinyl to the structural strength of metal for an ever-widening range of products... from business machines to auto and bus interior panels... from TV cabinets to telephone booths! Sheets of steel, aluminum, magnesium or copper, *prefinished* by the Marvibond Process, can be shaped, sheared, drilled and punched on standard sheetmetal-working equipment without damage to the flexible vinyl surface.

We do not make Marvibonded laminates or the products shown here, but we have licensed many laminators throughout the country to use the Naugatuck-developed Marvibond Process. We'll gladly give you the names and addresses of several licensees near you.

*Poloron Products, Inc., New Rochelle, N.Y.

†U. S. Pat. No. [illegible]

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For the Sake of Argument

"It Takes All Kinds . . ."

By Norman G. Shidle

Psychologists say there are two types of mind. One works logically from A to B to C to reach the solution to a problem. The other works by association of ideas; it is called "the creative type."

This classification isn't news to anybody who has been working with people for more than a few years. Most of us have classified ourselves and our associates as being in one or the other group . . . or somewhere in between. And most of us, too, tend to give relative values to the two types.

Clear recognition that two types do exist frequently will permit enrichment of their combined efforts. Recognition may make the ABC-type less apprehensive of the association-type, which so often seems to them flighty, unsound . . . even eggheaded. And it may make the association-type less critical of the ABC's, whom they often regard as pedestrian, unimaginative . . . even slow-witted.

Both types, of course, have their strengths and their weaknesses. The ABC mind may have trouble staying open to receive ideas, when they come too fast for immediate ABC-type absorption. The creative mind may have to guard against using its recognized creativeness as a handy alibi for not seeing a detailed job through.

"I have known 'creative' management," an executive said recently, "to lose all awareness of the sustained effort and time required to make its creations realities. As a result, it simply became impatient with those to whom the 'birthing' was assigned."

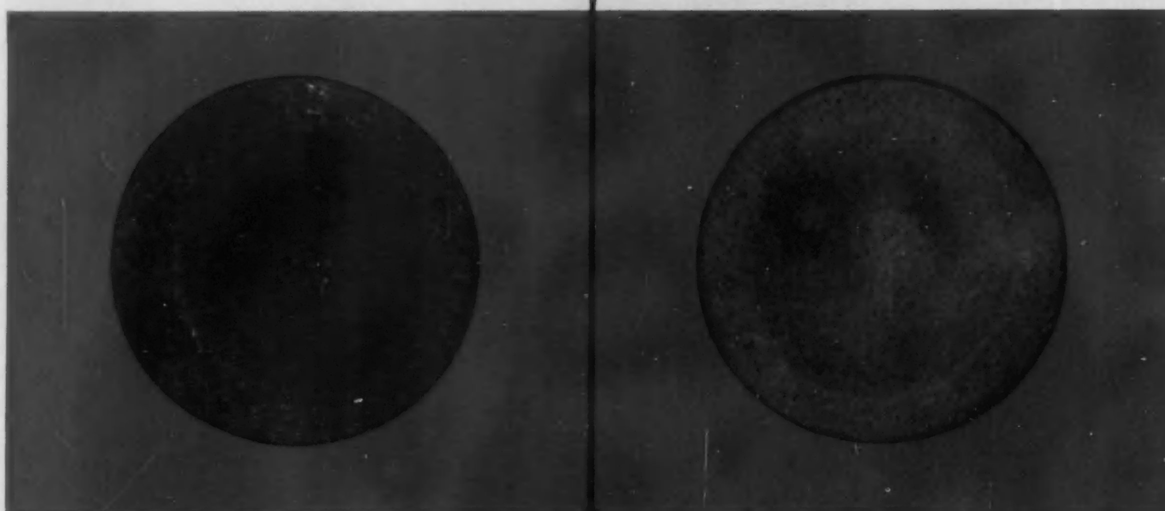
This same executive, rated by both psychological test and associates as definitely the creative type, also had this to say:

"I question if life permits one to function exclusively through association of ideas. The process can, of course, be used repeatedly within a single problem. But once in a while it seems necessary to go from A to B to C, if only to prove what the association has revealed.

"We should avoid giving relative values to the two types of mind. The tendency is to claim superiority for the creative mind. Maybe so, but I see no gain from such evaluation. There is an equal place and a need for both. . . . Both have to work together. And with understanding, they can do so with less friction and more fruitfulness."

The EATON Process of Aluminizing Exhaust Valve Heads PREVENTS PRE-IGNITION

CAUSED BY INCANDESCENT SCALE



NOT ALUMINIZED
Note Scale which Promotes Pre-ignition

ALUMINIZED
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Conventional exhaust valve steels, run at high temperatures, tend to corrode and scale, promoting damaging pre-ignition. This condition can be overcome by the use of expensive high-alloy materials. However, there is a simple and less expensive solution to the problem. By applying the Eaton aluminizing process to conventional exhaust valve steel, resistance to corrosion and scaling can be increased tremendously, thereby eliminating a condition which can be a major cause of pre-ignition.

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Editor

Frances L. Weeden
Managing Editor

SAE JOURNAL PUBLICATION OFFICE

Business Press, Inc.
10 McGovern Ave.
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EDITORIAL OFFICE

485 Lexington Ave.
New York 17, N. Y.
Tel.: OXford 7-3340
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ADVERTISING OFFICES

E. D. Boyer
Eastern Advertising Manager
485 Lexington Ave.
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SAE DETROIT OFFICE

R. C. Sackett, Staff Representative
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SAE WESTERN BRANCH OFFICE

E. W. Rentz, Jr., Manager
Western Branch Office
Petroleum Bldg.
714 West Olympic Blvd.
Los Angeles 15, Calif.
Tel.: RIchmond 9-6559

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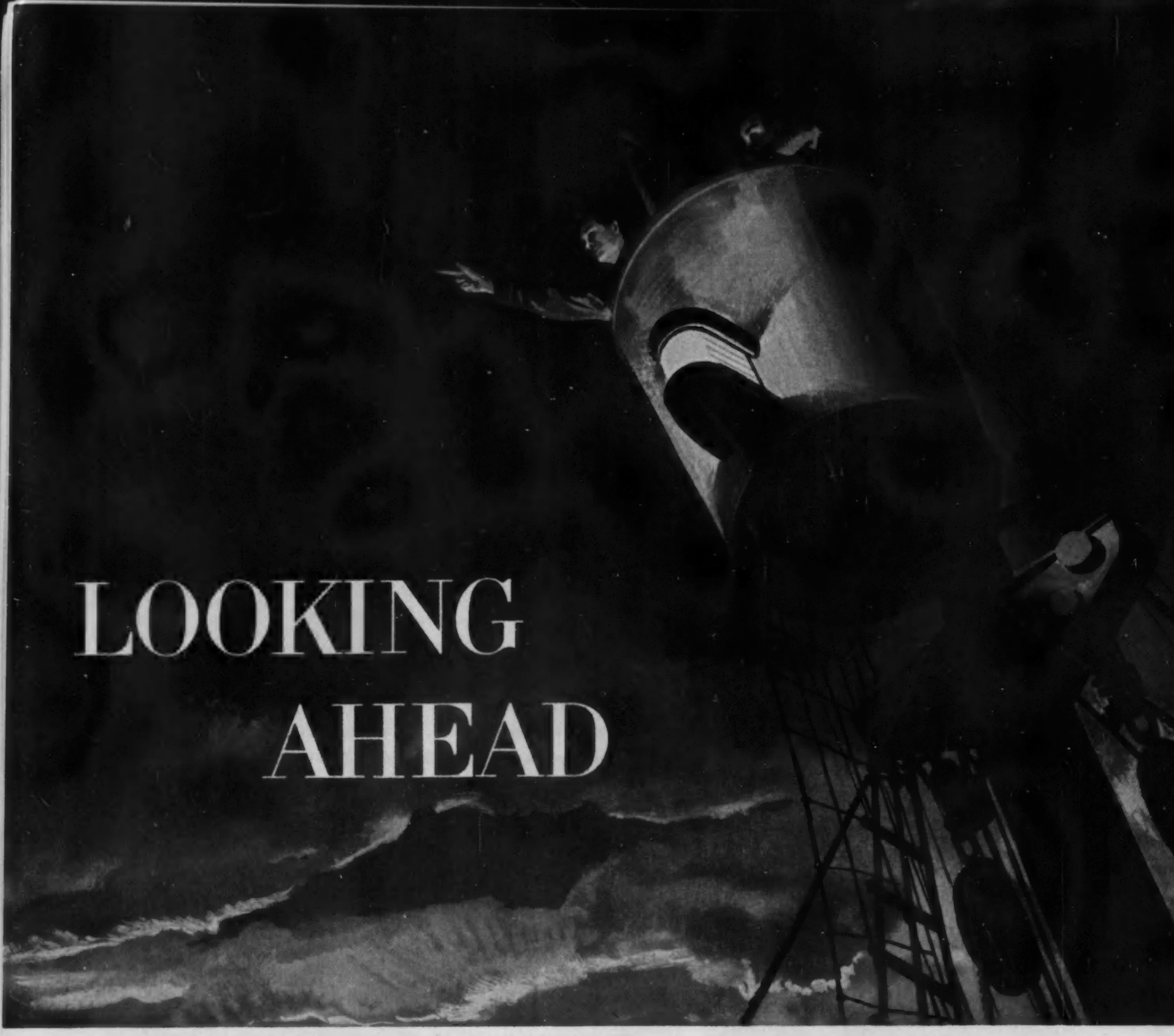

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For example, Bendix* Power Braking and Power Steering are today two of the industry's most popular new car features because Bendix started planning them years ago.

Likewise, new products now being developed at Bendix Products Division may well be expected to make automotive headlines on future new car models.

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White-coated men of pure science mingle more and more with business-suited practical engineers to solve the problems facing . . .

The New Automotive Engineer

ALERT automotive engineers are talking of radiation as well as radiators, of market research as well as metallurgy, and of solid state physics as well as liquefied petroleum gas.

The SAE Annual Meeting (January 14-18 in Detroit) demonstrated that while traditional fields like mechanics, thermodynamics, and hydraulics are the core of automotive engineering, the men who practice the profession know that they must concern themselves more and more with scientific developments in other fields.

"Automotive" still means "self-propelled by internal combustion engines" to SAE men; but there's hardly a field of science that doesn't offer data or techniques for improving automotive products. The new automotive engineer is one who can delve into these "alien" areas and bring back ideas and techniques which can be adapted to conventional automotive engineering.

He considers nuclear energy is just another form of energy as electrical energy is. Dr. L. F. Hafstad pointed out (in a luncheon speech) that overlooking the possibilities of nuclear energy for ground and air vehicles would be comparable to refusing to make use of electricity in headlamps, self-starters, and electronic instruments.

The impact of nuclear energy on automotive engineering is told more fully on pages 41-69 of this issue.

The new engineer is being asked to make use of social research techniques in determining what type of product he should design. Prime example of this is the planning for the new Edsel, which will be placed on the market next fall.

Surveys by Ford showed that each year many low price car owners were "graduating" into the medium price market and medium price owners were buying higher priced cars. Since Ford had only one car (Mercury) in the medium price field it was able to retain only one fourth of its low price customers as they moved into the medium price field, while other companies gained about three fourths of its graduating low-price customers. So Ford is

Men shown in photograph at top of page are Henry J. Gomberg, assistant director of the University of Michigan's Phoenix Project on peacetime uses of atomic energy; James S. Brierley, business manager of Chrysler's Nuclear Research Program; Henry J. Ogorzaly, coordinator of nuclear activities for Esso Research; Clayton R. Lewis, chief engineer of Chrysler's Nuclear Research Program; and Ray McBrian, director of research for the Denver and Rio Grande Western Railroad.

coming out with the Edsel to fill this gap between low and high price lines and keep its customers in the family.

In determining what is saleable, the new engineer must take into consideration the psychology of the owner. To the customer the automobile is more than transportation . . . it is a symbol of prestige and status. Automobile companies devote years to probing customers' minds to find out what their reactions are to existing automobiles and what would appeal *emotionally* to the prospective buyer.

The customer wants long, low cars with high horsepower—so the engineer designs them that way. Since styling is the most important single factor, the appearance of the car is given prime concern. And since the owner judges a car by how it "feels" to him, the engineer must stress comfort, ease of driving, absence of squeaks, and low engine noise level.

Like many other measuring techniques the engineer uses, market research often gives different answers to a basic question, depending on who applies the yardstick. This was illustrated by reports on the market research that helped determine specifications for two new corporate aircraft. A market study convinced one design team that the customer wanted a four-engine airplane for all-weather reliability. So, the designer looked over the field of available small turbine engines and came to the conclusion that no engine of suitable power ready for the market at present had good enough fuel economy. The team selected piston engines for its aircraft, the Cessna Model 620.

Another company, Fairchild, found that its mar-

Diesels and their fuels

. . . continue to interest automotive engineers.

IN SPITE OF the glamor of the so-called *new* sciences—such as nucleonics, electronics, and hypersonics—automotive engineers at the SAE Annual Meeting indicated that down-to-earth applied engineering—such as diesel-engine development—would continue to be of vital importance. Eleven of the technical papers presented at the meeting were concerned with getting better performance from existing diesel engines and fuels and devising new concepts for designing new railroad, truck, and bus diesel engines. Some of the ideas brought out are as follows:

- Maximum horsepower can be obtained from the poorest quality fuels. (That is, residual fuels of low volatility and low cetane index.) Best fuel economy at full-throttle operations is also obtained from these heavy residual fuels. However, savings are offset by increase in engine deposits, contamination of lubricating oil, excessive exhaust smoke, valve corrosion, and the need for more frequent engine overhaul. Use of the very heavy residual fuels requires modification of injection systems to foster better combustion, and better fuel filters, both of which are expensive.

- In dual-fuel-system diesel locomotives, tests have shown that a low-cost residual distillate of 300 SSU viscosity (at 100 F) can be used successfully with a minimum of expenditure for special equipment. Almost $588,000 net fuel savings were recorded during a 4-year experiment using light residual fuel in a fleet of 50 locomotives. These engines had an automatically controlled fuel system which burned distillate fuel during idling and low load and light residual fuel at high engine loads.

- Hercules Motor Corp. has produced a series of gasoline and diesel-engine models from the same basic engine design without compromising performance, weight or cost of either engine. Cylinder blocks, crankshafts, valves, valve gear, connecting rods, gear covers, and bell housings are identical in 18 different engine models. This design cuts manufacturing costs and simplifies the service parts program.

- Continental Motors has developed a 75-hp, air-cooled diesel for armored vehicles that, it is claimed, consumes 40% less fuel than the previously used gasoline engine. The 4-stroke-cycle engine is light, compact, and has 1790 cu in. displacement and 12 cylinders.

- A basically different combustion process, called bi-fuel burning, looks promising for a certain type of diesel engines. Very low quality fuels can be burned effectively without too much exhaust smoke under conventional operating conditions. Wear and combustion chamber deposits are kept low. This process, developed by Sinclair Research Laboratories, uses a small amount of an easily ignited fuel, such as kerosene, to trigger the ignition of the heavy distillate.

- Electron microscopes are being used to determine diesel fuel quality. By becoming thoroughly familiar with the shapes, sizes, degree of agglomeration, and frequency of particles occurring in fuels of known quality, the microscopist is able to predict the performance and stability of new or unfamiliar fuels. Phase and polarized light microscopy can also be used to supplement electron micrographs in the study of diesel fuels; however there is a need for basic correlating data.

ket expected a 10- to 15-year useful airplane life. However, Fairchild reasoned that well before the end of that period executives will be "turbo-conditioned" by the airlines and will not care to ride in a piston-engine plane. So, Fairchild decided to build the turbo-prop powered F-27.

Whether or not corporate aircraft provide a sizeable market for small gas turbine powerplants, their makers are confident of the future of their products. Their own market studies, plus engineering evaluations of the gas turbine, lead them to believe that they have adequate markets in military helicopters, boats, trucks, buses, and starters for bigger aircraft turbines.

Airport designers are profiting from psychology. Discussion on how to reduce congestion at airports brought out that maybe a little congestion is a good thing. It gives the onlookers something to watch. The stay-at-homes who go to the airport to see off or welcome passengers are good prospective passengers. They're also customers for the restaurants, gift shops, and other tenants that help the airport to break even.

The new engineer is also borrowing a leaf from the artist's notebook, by using more and more graphic illustration in product engineering. He finds it a useful means of communicating with non-technical personnel in a common language (pictures) they can understand. For instance, where in the past an engineering idea was presented in the form of an orthographic drawing blueprint, now an artist renders it into perspective pictures. Since it contains pertinent notes, parts numbers, and dimensions, the graphic illustration replaces rather than supplements certain orthographic drawings. The pictorial perspective is extremely useful in advertising, employee training, maintenance manuals, management reports, conferences, and purchasing. In fact, the use of artwork in an area which previously used only complicated engineering drawings has enabled all phases of management, service, sales, and production to know more about the product.

Sociologists have predicted that as long as national prosperity continues there is reason to expect that frozen food sales will double in the next four years. This affects automotive engineers in the increased need for refrigerated trucks. So, SAE invited a refrigeration engineer to tell how to select refrigerating equipment and build trucks to prevent food spoilage in transport.

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W. PAUL EDDY took over the SAE presidency from 1956 SAE President George A. Delaney at the business session held during Annual Meeting. Eddy typifies the automotive engineer of broad scientific interest. As chief of engineering operations at Pratt & Whitney Aircraft, he directs the Inspection Department, Materials Engineering Department, Experimental Construction Department, Experimental Hangar and Flight Test, and Experimental Test Laboratories. His company's current interests range from aircraft piston engines to turbine powerplants and atomic propulsion.

Transmissions Pace Truck Needs. . . .

Methods vary and choice is wide. But there is no let-up in drive for more flexible, efficient designs.

THE methods used to transmit truck engine power to the driving wheels grew like Topsy and vary greatly. That some of the oldest methods are still very widely used indicates that no one method is the best. It is the intended service that decides use.

In the early days, when vehicle and engine speeds were low, 3- or 4-speed transmissions were adequate. Then, as roads improved and vehicle loads and speeds rose, more ratios were needed, so 4-speed and then 5-speed types were developed.

At this point came the first radical departure—the auxiliary transmission. If the ratio spread in the forward transmission is sufficient over all but too great between ratios, then the auxiliary splits these ratios for improved performance. If the ratio spread is inadequate in the forward transmission, then the auxiliary can provide a deep ratio to increase the overall spread. Common practice is to use a 3-speed auxiliary behind a 4- or 5-speed transmission.

The 2-speed axle, serving as a gear splitter, arrived in the early thirties, featuring less weight than the auxiliaries. The difference in the ratio from high axle range to low axle range varies somewhat on design, but is commonly around 36%. A conventional 2-speed requires going through the main transmission only once from start to full speed and changing a button to select the axle shift where required.

Still another method which came into use is the 10-speed, short step transmission. In effect it is a conventional transmission with close-spaced ratios used twice to cover the desired all-over range. The ten ratios being evenly and closely spaced are controlled by a single gearshift lever and the time required for all shifts is equal under similar conditions of operation.

In an effort to improve on the 10-speed transmission a fourth method has arrived in the form of a wide-range 2-speed axle in combination with a short step 5-speed transmission. This method provides two useful ranges. In congested areas the slow range can be used exclusively, while in open country the fast ratio will serve. This method gives the same results as the 10-speed transmission but accomplishes a saving in weight.

All these methods of transmission are in common use today.

This article is based on papers presented at the Round Table on Range and Splitter Ratios in Transmissions and Axles. The authors are:

Elmer Barth
Dana Corp.

T. Backus
Fuller Mfg. Co.

C. D. Christie
Eaton Mfg. Co.

N. R. Brownyer
Timken-Detroit Axle Division, Rockwell Spring & Axle Co.

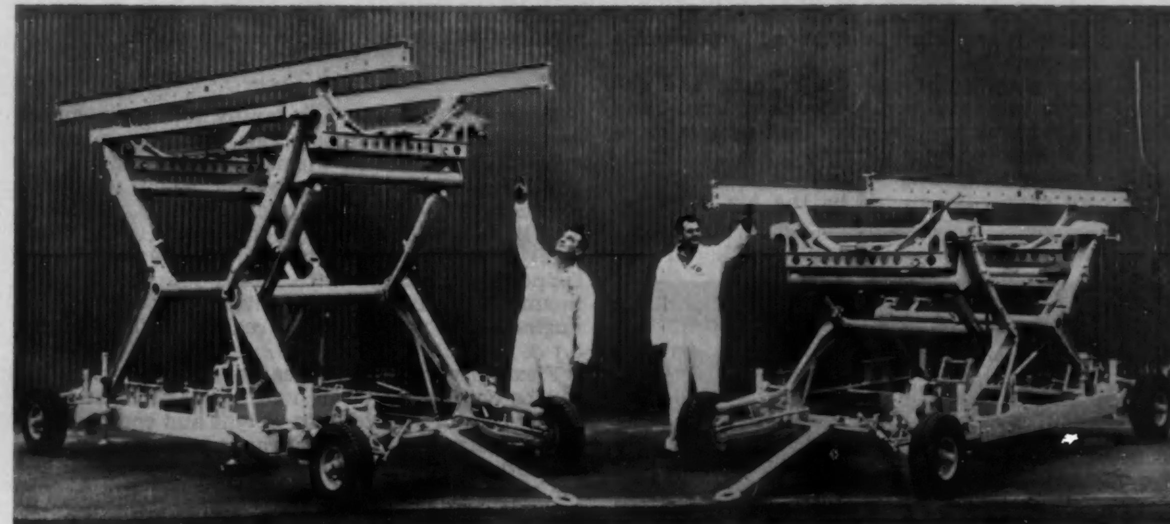


Fig. 1—The Model 4100 (left) and the Model 4000 A (right) Positioning Trailers replace 151 former single-purpose engine removal units.

Equipment for Ground Support Of a Modern Air Force

L. R. Hackney, Air Logistics Corp.

Based on paper "The Influence of a Ground Support System on Combat Mobility."

A MODERN Air Force requires a strong ground support system if it is to have the readiness and mobility necessary to wage a sustained war.

Positioning Trailers

One piece of equipment in such a support system is the Model 4000 Positioning Trailer, developed by Air Logistics Corp. With standardization as a principal objective, the present two versions of this trailer (Fig. 1) are capable of replacing 151 sundry engine removal units.

The Model 4000 A and its high-lift brother, the 4100, utilize parallel I-section rails that permit engine or aircraft components to be roll-transferred rapidly, without cranes or other special equipment, to the matching rails on other elements of the Air-Log system. Precision positioning is achieved through a combination of hydraulic irreversible screw-type actuators which provide fore and aft tilt, roll, and yaw, together with linear movement in three planes. An irreversible-gear-actuated winch moves heavy objects along the rails when the rails are inclined. Complete wheel retraction is provided as well as 90 deg wheel rotation on all wheels.

Multiple-Purpose Transportation Trailers

The next important links in the system chain are the Air-Log Model 2000 and Model 3000 Multiple-Purpose Transportation Trailers. The Model 2000 (Fig. 2) is a smaller and lighter-weight version of the Model 3000. The Model 2000 has a capacity of 4000 lb with a weight empty of 340 lb while the Model 3000 carries a payload of 8000 lb and weighs 500 lb empty.

These units are used for air, truck, rail, and ground transportation as well as for build-up and minor repair of jet engines and aircraft components. The Model 3000 will handle all jet engines now under production or development. In addition, it will

handle most demountable aircraft stores and components as well as certain missiles or demountable missile components.

The spring action of the trailer rails and the mixed spring rates involved in the tires, frame, and rails furnish shock and resonant load protection to the carried article under all transportation conditions including tie-down.

A recent survey conducted by the Air Force revealed that these two transportation trailers have replaced 302 single-purpose design units.

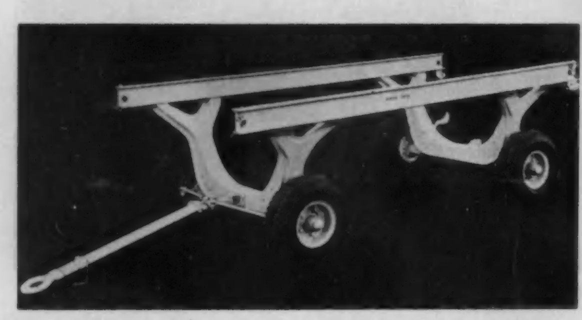


Fig. 2—The Model 2000 and its heavy-weight brother Model 3000 (not shown) Multiple-Purpose Transportation Trailers replace 302 former single-purpose design units used for build-up and minor repair of jet engine and aircraft components.

Subsystems

From the basic Air-Log family tree have sprung several branches, or subsystems, which are complete subsidiary systems in themselves. One of these is the **Minor Engine Repair System,** which uses basic elements of the Air-Log System; namely, two Model 3100 light-weight portable workstands (with folding legs) in conjunction with a Model 4600 Yoke which supports an I-beam with two 1-ton chain hoists mounted on trolleys. With this system complete jet engine minor repairs can be readily performed (Fig. 3.)

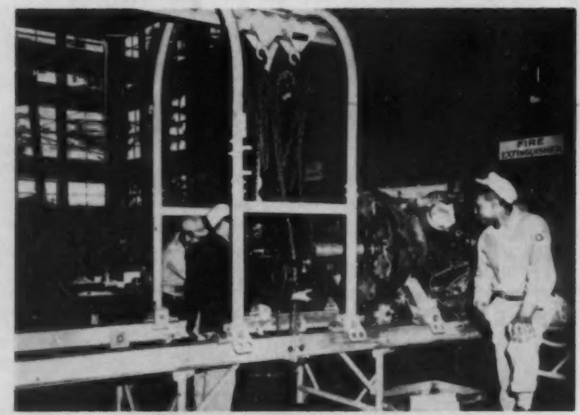


Fig. 3—Two Model 3100 light-weight portable workstands in conjunction with a Model 4600 Yoke permit jet engine minor repairs to be readily performed.

Flexibility is the main feature of this system. It can be quickly set up in a corner of any hangar of an air base or, due to light weight and compactness, be air transported to any advance base.

Another subsystem, providing both flexibility and air transportability, is the **Engine Run-Up System** (Fig. 4). Here again, basic elements are utilized to provide a light-weight, highly-portable engine run-up installation. Two standard Model 3000 Transportation Trailers perform this task. One trailer is modified to handle the engine to be run up. The other trailer, with a fuel tank mounted on adapters and containing the control panel, constitutes the second member of this versatile, yet vitally important, two-unit team.

Fig. 4—Two Model 3000 Transportation Trailers are used to provide a lightweight, portable engine run-up installation. One trailer is modified to handle the engine to be run up (not shown). The other trailer has a fuel tank mounted on adapters and contains the control panel.

New Ground Support Equipment

A new piece of equipment is the Model 6000 **Engineering Specialist Trailer** (Fig. 5). This unit is de-

Fig. 5—The Model 6000 Engineering Specialist Trailer permits equipping specialized service personnel with tools, test equipment, check-out equipment, standard spare parts, or administrative or technical data—a different version of the basic trailer providing each service.

Fig. 6—Another version of the basic Model 6000 trailer is suggested for use as a Mobile Infirmary. The sketch shows a 16-bed portable unit.

signed to implement current specialized maintenance and tactical mobility concepts. It permits equipping specialized service personnel, in a compact, light-weight, and highly mobile form, with any one of the following:

1. Tools
2. Test Equipment
3. Check-out equipment
4. Standard spare parts
5. Related administrative or technical data

With its ground mobility features, the different versions of the Model 6000 trailer permit specialists to cover widely dispersed aircraft. Its air mobility features allow rapid withdrawal from an operating base and permit it to be immediately operational at the destination base.

Most versions of this trailer are designed to include internal electrical and pneumatic supplies in addition to providing 40.1 sq ft of bench area and 57 cu ft of stowage space. The test and check versions of the trailer use external power and contain 74.7 cu ft of stowage volume.

Fig. 6 is a sketch of a design proposal submitted to the medical branch of the military for a version of the basic Model 6000 to be used as a **Mobile Infirmary.** The trailers are equipped as a complete facility for the stowage, transportation, and operation of a mobile field hospital and dispensary. The sketch shows a 16-bed portable unit.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N.Y. Price: 35¢ to members; 60¢ to nonmembers.)

Turboprop Engine . . .

. . . with supersonic propeller promises hot competition for turbojet. Potentials justify speed-up of engine-propeller development.

Based on paper by **Daniel H. Jacobson and Robert A. Rogers,** Allison Division, General Motors Corp.

THE turboprop with supersonic propeller has advantages over the turbojet for long range airplanes up to speeds of Mach Number 1. Short takeoff distances, good fuel economy, and high angle of climb and descent, all recommend that development be accelerated.

The aerodynamic efficiency of propellers has been improved and further gains are in progress. The successful design of the supersonic propeller depends, of course, upon the stresses the design must withstand in service. A reduction in drag losses is chiefly accomplished by decreasing the thickness ratio of the blade sections. Because high rotational speeds are needed to maintain low advance ratios at high forward speeds, comparatively high levels of stress will be experienced.

Steady stresses in a blade are caused by centrifugal force, bending due to air-loads and torsion. The vibratory stresses are those due to inflow angularity at the propeller disk resulting in a once-per-revolution excitation and stall flutter which occurs at take-off when the blades are highly loaded. While the advance ratio has been shown to be an important parameter with respect to propeller efficiency at high speeds, it is also a governing factor in determining the centrifugal loads and stresses on propeller blades, hubs, and pitch changing mechanisms.

Centrifugal Stresses

At supersonic speeds the major steady stress in blades is the centrifugal stress which is a function of the blade mass distribution, the density of the blade material, and the square of the rotational velocity. Since the centrifugal stresses and loads vary as the square of the rotational velocity, it is desirable to keep the rotational speed as low as possible yet compatible with the advance ratio for good propeller efficiency at the design condition. While the centrifugal stresses are effective limits in establishing general propeller configuration, the vibratory stresses caused by stall flutter limits the blade thickness ratio. Experimental data have shown that for a given type of airfoil section at a constant angle of attack, the critical flutter velocity is principally a function of the product of chord and torsional frequency.

The torsional frequency of a blade is an integrated function of its polar moment of mass inertia and its torsional rigidity. The torsional frequencies of a family of constant chord, solid section blades having a thickness ratio varying from 0.015 at the tip to 0.030 at the 30% radius, show the basic desirability of large chords with respect to avoiding stall flutter. However, the penalties of increasing chord are tremendous.

Of primary importance is the effect on the pitch changing mechanism where the centrifugal twisting moments of the blades vary as the fourth power of the chords. In addition, the blade weight and centrifugal force are proportional to the square of the blade chord. Thickness ratio is also a primary parameter in evaluating the torsional frequencies of blades. For these reasons a compromise is necessary involving first an increase in thickness ratio or, second, a tapering of the blade planform, both of which increase the torsional frequency. In addition, the structural and weight compromises must be compatible with the aerodynamic performance usually defined by the maximum cruising speed and take-off thrust conditions.

The design life of a blade is predicated to a great

extent on the magnitude of the 1×P stresses encountered at the various operational conditions. These vibratory stresses are caused by the airstream entering the propeller disk at an angle to the direction of thrust. The vibration occurs because each blade element operates at a varying angle of attack and velocity as it rotates and, consequently, causes fluctuating lift forces which complete an excitation cycle once each revolution.

In general, the vibratory stresses on supersonic type propellers are low. However, it is essential that the natural frequencies of the blade design be sufficiently removed from the normal operating frequencies of the propeller. If low thickness ratios are to be retained, this may be accomplished by tapering the blade planform. (Paper "Propellers for High Speed Aircraft" is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members, 60¢ to nonmembers.)

Fuel Cost . . .

. . . is real key to gas turbine locomotive operation, according to extensive experience by UP railroad.

Based on paper by **Ross C. Hill,** Union Pacific Railroad Co.

SIX million miles of experience by Union Pacific clearly points up the fact that the real key to gas turbine locomotive operation is the development of plentiful sources of cheap specification fuel. Thus, the UP operation has been successful because the railroad has been able to supply its locomotives with a relatively low-cost residual fuel blended or treated to suit the limitations of the turbine. (In the future, this will be more difficult, but there is still the cushion of costs for maintaining a basically simple nonreciprocating, single-unit locomotive compared to the cost of multiple-unit, reciprocating-engine locomotives.)

Briefly, the builder's specification for gas turbine fuel oils is as follows:

1. Viscosity: 95 SSU at nozzles with a maximum temperature of 250 F satisfying stability limit of Item 3.
2. Character of ash:
   (a) Weight ratio of sodium in ash to vanadium in ash not greater than 0.3.
   (b) Weight ratio of magnesium in ash to vanadium in ash not less than 3.0.
   If vanadium content is less than 3 ppm, magnesium ratio need not be followed.
   (c) Sodium content of oil should not exceed 10 ppm.
   (d) Calcium content should not exceed 10 ppm.
   (e) Total ash content should not exceed 2000 ppm.
   (f) Additives must be soluble or finely ground to prevent settling before use.
3. Stability:
   Below 210 F—No. 2 tube or better (MIL F-859).
   Above 210 F—No. 1 tube or better.
4. Compatibility: No. 2 or better in the NBTL heater test with other fuels used.
5. Bottom solids and water shall not exceed 2%.
6. Sulfur content shall not exceed 3½%.

This specification is quite restrictive when compared to ordinary No. 6 or Bunker C fuel. Eventually, the gas turbine must digest a No. 6 grade fuel oil, because it is very advantageous to have unrestricted access to fuel stocks of various refiners along the railroad and to obtain such fuel at lowest market price. Since the basic thermal efficiencies are fixed for any particular load factor, it is necessary that fuel costs be controlled in order to make turbine engines fulfill their promise. As shown in Fig. 1, the economical limit for cost of turbine fuel is reached when turbine fuel price becomes 34% of the price of diesel fuel. This is based on a turbine load factor of 50%. (Paper "Six Million Miles of Experience with Gas Turbine Locomotives" is available in full, in multilith form, from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members, 60¢ to nonmembers.)

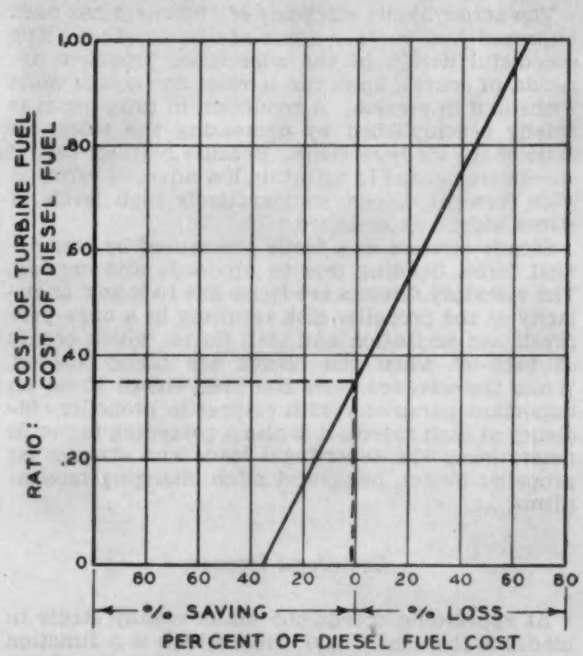
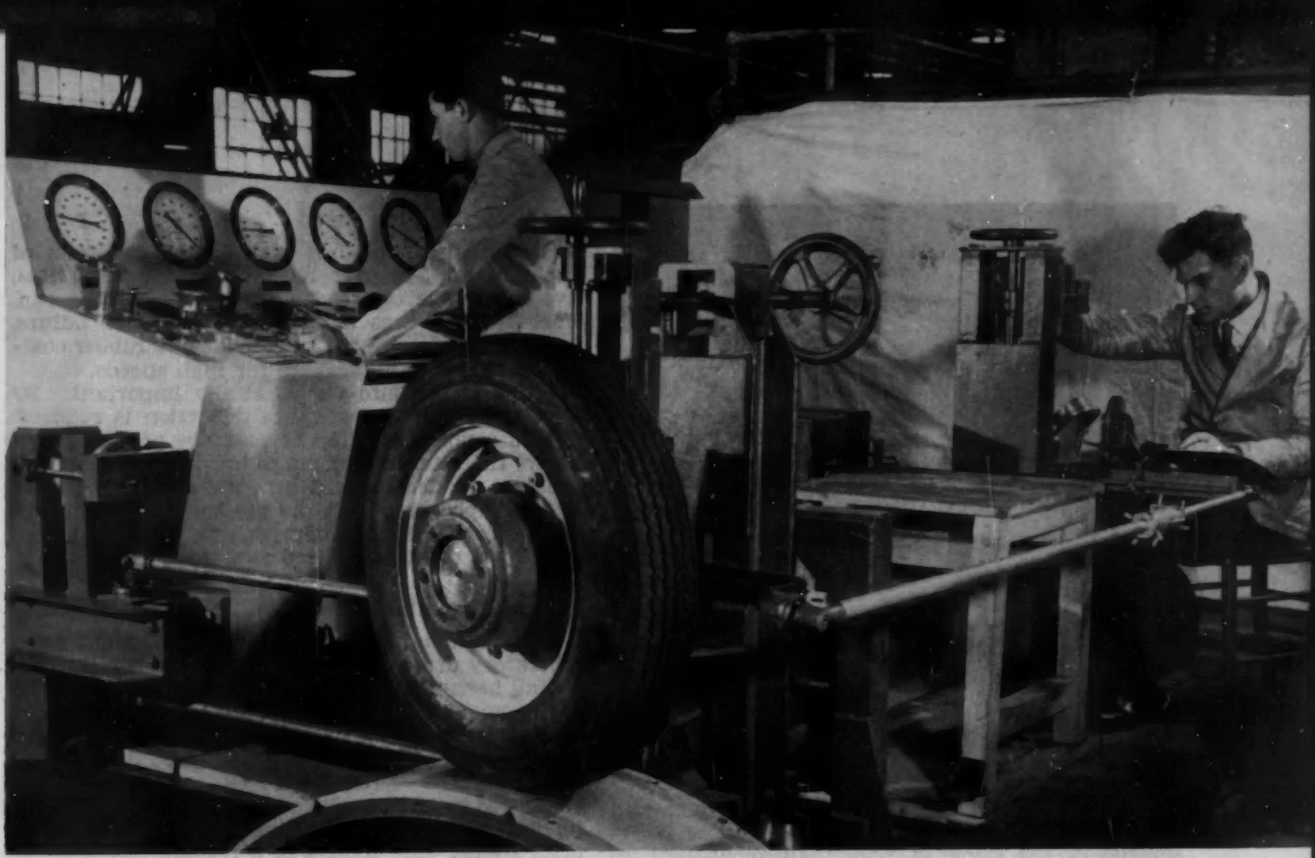


Fig. 1—Relationship between cost of turbine locomotive fuel and diesel locomotive fuel at 50% load factor. Note that economical limit for cost of turbine fuel is 34% of price of diesel fuel.



Lab equipment gives reliable data...

Testing High Speed Tires

E. F. Powell, Dunlop Rubber Company, Ltd.

Based on paper "Some Aspects of High Speed Tire Testing."

TIRES for high speed cars can be tested accurately and reliably in the laboratory at considerable savings in time and expense. Of course, road testing is also desirable. However, road tests can be planned more efficiently after preliminary indoor tests. And for tires to be used on special racing cars and aircraft, full laboratory evaluation is essential for safety.

THE Dunlop Rubber Co. Ltd., England has developed machine testing methods and has correlated results with service performance. Their procedures give a good indication of the tire's capabilities.

Most of the machine testing is done on a smooth steel drum with an electrical drive that has a very flexible speed range. Speed can be held steady within 1% and a torsion dynamometer is included in the drive to measure tire power consumption.

The machine has devices for very rapid loading and unloading of the tire on to the drum and a spin-up drive mounted on the beam so that tire speed can be matched to the drum before touching. This will avoid variable acceleration time and reduce tread damage due to slippage at very high speeds. Fig. 1 shows the machine.

One of the interesting phenomena disclosed with this (and other) testing machine is "tread ripple." It is sometimes called "traction wave" and is caused by the oscillatory recovery of the tire after deflection. (See Fig. 2.)

Rippling causes a sharp rise of rolling resistance

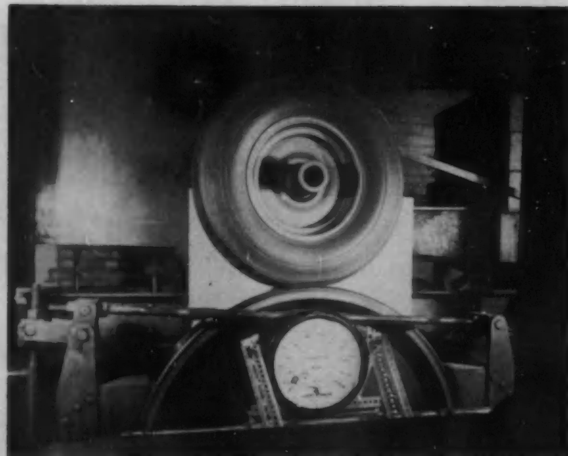


Fig. 1—High-speed tire testing machine used in Dunlop laboratories.

(which, in fact, begins before ripple is visible) and consequent tire heating. Tire life is reduced if the severity of the ripple is more than about 1/20 in. Any given tire design has a top speed ceiling due to rippling.

Tests using a high speed camera have indicated that:

1—The definite speed at which ripple starts is controllable by tire design.

2—Ripple increases sharply as speed increases. It is not possible to drive through to a higher speed where the tire again runs normally.

3—By increasing inflation pressure the onset of ripple can be delayed to a faster speed. One psi increase lifts ripple speed about 2 mph.

4—Tire loading has negligible effect on ripple.

Road tests at high speed

Dunlop also ran some high-speed road tests of about 20 min. at over 100 mph. Of twenty tires, five failed due to tread stripping during the run. Heat build-up was not the only cause of failure. Some of the tires tested were made of a rubber compound that was inadequate for high speeds.

Inflation pressure rise is vitally important. By increasing inflation pressure deflection is reduced. It also compensates for normal tire growth which allows the internal volume to increase and internal pressure to decrease. Warm-up runs between 60 and 90 mph, which lift the pressure to within 1 or 2 psi of the final maximum, are advised before starting a maximum-speed run.

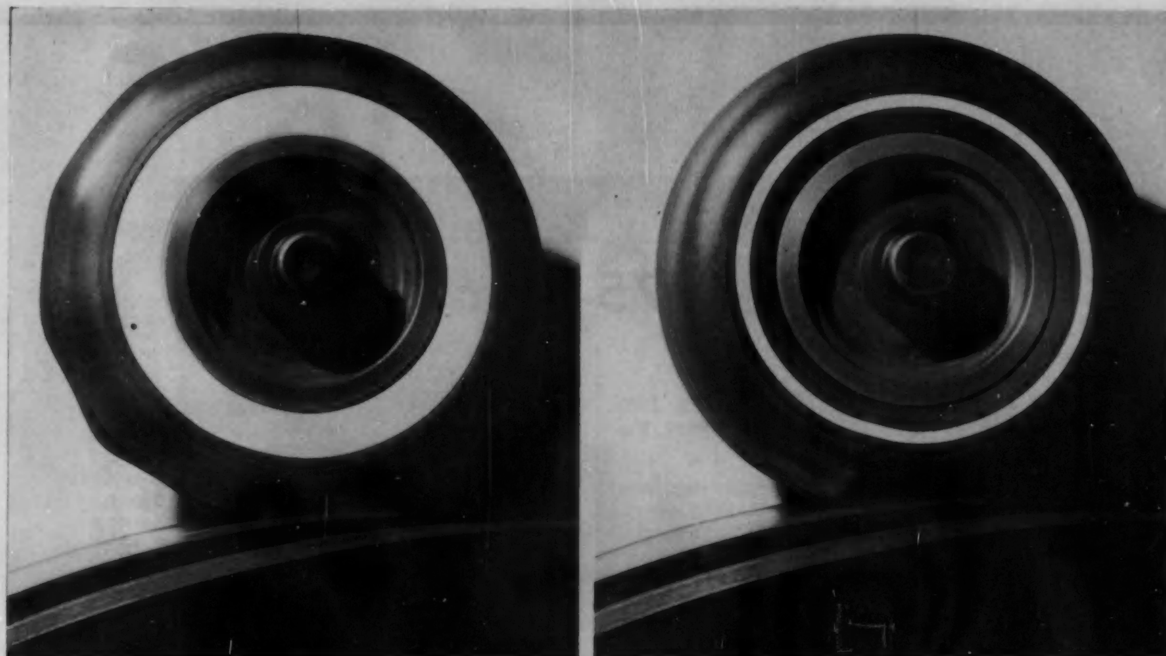
Endurance tests

Dunlop found that speeds up to 50 mph on a laboratory drum machine gave closely similar cornering behavior results as road tests. The rate of development of lateral forces after steering, which is governed by distance travelled rather than time, is an important factor in normal-speed driving, but less important at very high speed. After a sudden change of heading the tire takes up its steering distortion and generates 99% of its full lateral forces after rolling only some 2 or 3 revolutions.

Dunlop's measurements made on a flat board pulled slowly under the tire suggest that only about one revolution is necessary to give 90% of the ultimate value of cornering force. Since steering movements at high road speeds are slower in relation to distance travelled on the road, this adjustment rate is not a major factor in high-speed steering behavior.

(For complete paper on which this abridgment is based write SAE Special Publications Department, 485 Lexington Ave., N. Y. 17. Price: 35¢ to members; 60¢ to nonmembers.)

Fig. 2—Standing waves or tread ripples occur at high speeds due to the oscillatory recovery of the tire after deflection. The waves are stationary in space, the tire material moves through them. Rippling causes a sharp rise in rolling resistance and consequent tire heating.



(Left) A regular tire at 140 mph has a pronounced standing wave. (Right) A specially built (by U. S. Rubber Co.) high speed tire running at 140 mph and 24 psi inflation shows a standing wave starting to develop. When inflation pressure is increased to 35 psi, the standing wave disappears.

Discussion

W. H. Hulsit

United States Rubber Co.

To improve a tire for high speed use, three major parameters may be adjusted:

1. The tire weight can be reduced, particularly in the crown region.
2. The cord angle can be reduced; that is, made more nearly circumferential.
3. The inflation pressure can be increased. (See picture at top of page.)

M. A. Wilson

Goodyear Tire and Rubber Co.

Tread separation was formerly considered the primary cause of tire failure in this country. However, as improvements in compounds and constructions have been made, we find tread chunking is the major limiting factor in continued high-speed operation of standard tires. We have found that tread chunking is not confined entirely to high-speed operation, but in some cases it is preceded by the tearing or cutting of tread elements resulting from wheel spinning and highly accelerated forward motion of the car, extremely sharp cornering, or rapid deceleration and wheel skidding.

We have made substantial use of nylon in our tires. We feel nylon's strength and heat resistance characteristics, which provide comparative freedom from carcass failure and superior high-speed performance, will become the tire cord of the future for better grades of passenger car tires in America.

W. F. Perkins

B. F. Goodrich Co.

In general, our tests have shown that:

1. Failure at high speed almost invariably comes from tread stripping or portions of the tread tearing from the tire.

2. A rapid pressure rise from starting pressure is necessary for safe operation. Usually the wet air found in most service station air lines is a distinct advantage. Tires that are warmed up to at least 1/3 higher than starting pressures before starting a high speed run are relatively safe at 100 mph or higher speeds. Tires started at higher pressures than normal need less warm-up time to reach safe operating pressures.

More About High Speed Tires

In the January, 1956 SAE Journal there appeared an article **"Cornering Can Wear Tires Rapidly"** based on a paper by **V. E. Gough.**

An article appeared in the March, 1956 SAE Journal entitled **"High-Speed Tire Performance"** based on a paper by **T. J. P. Joy, D. C. Hartley, and D. M. Turner.**

Arthur J. Scaife
1875-1956

Arthur J. Scaife, president of SAE in 1932, died on Nov. 28, 1956, in St. Petersburg, Fla.

Scaife devoted much of his early business life to applying trucks to specific field operations and his "little black data-book" was well known in that field.

He had been associated with the development of the motor truck since it was a "pup," having joined White Motor Co. in 1900. He was affiliated with that company from the turn of the century until 1937. Throughout his years with the White Co. he was in the engineering department. He started field engineering work in 1923 and in the following year was made chief factory service engineer. He became consulting field engineer for White in 1929 and in the later part of 1935 went to the West Coast to represent that company as transportation engineer.

Scaife went with the Autocar Co., Ardmore, Pa., in 1937, and two years later joined the firm of Dean Gillespie & Co. as consultant.

At the outbreak of World War II he joined the U. S. Army as senior ordnance officer in the Ordnance Department in Washington. Later he was made senior engineer in the Special Projects Branch for the Army's Development Division in Detroit. After the war he served in the Military Planning Division as chief of the Mechanical Section in Washington.

Retiring in 1948, he and his wife moved to Florida where they resided until his death.

Scaife worked prodigiously for SAE, having served on more than 80 of the Society's technical committees and executive groups. He became a member in 1910. As SAE president, he emphasized the growing importance of Sections by personally visiting more of them than any of his predecessors. His SAE committee work was centered around motor-truck research, standardization and coordination activities.

He had represented SAE on committees of the American Transit Association, American Electric Railway Association, and on the Standards Council of the American Standards Association. In addition he served on joint committees in which SAE has cooperated with the American Society of Mechanical Engineers, Automobile Manufacturers Association, American Petroleum Institute, American Society for Testing Materials, U. S. Army Quartermaster Corps, U. S. Army Ordnance Committee, and the U. S. Bureau of Standards.

Born in Cockermouth, England, his formal education consisted of eight years at public school, one year at Baldwin University in Berea, Ohio, and later extension courses in mechanical engineering.

Arthur J. Scaife
1875-1956

Pilot Errors Top USAF Accident Causes . . . .

SIXTY-SEVEN per cent of "cause determined" aircraft accidents in the U.S. Air Force during 1955 were caused by human factors. Maintenance and supervisory error accounted for some of those accidents, but pilot error was the factor of greatest magnitude.

The percentage of known causes in 1955 USAF accidents were as follows:

Unsafe Acts	*Approximate %*
Pilot Error	Over 56
Maintenance Error	Over 7
Supervisory Error	4
Unsafe Conditions	
Material Failure	Over 29
Airbase & Airways	1
Weather	1
Miscellaneous	2

Pilot Error Accidents

Pilot error accidents are the result of failure to meet certain basic requirements. But the term "pilot error" does not of necessity imply any neglect or fault on the part of the pilot. He might have made his error as a result of circumstances much beyond his control. In many respects, it is remarkable that pilots are not more frequently compromised into committing unsafe acts. They function in an environment and under circumstances which have no present or historical comparison—and for which they are often physically and physiologically ill-fitted to cope.

So, analysis of pilot error accidents can be broken down into the conditions affecting the human operator rather than into stages of flight as is frequently done.

There are three major considerations; these are the pilot's:

1. Physical condition.
2. Physiological tolerances.
3. Psychological or behavioral variances.

Physical Condition

With the careful selection exercised in choosing pilots, physical incapacity should not be a significant cause of pilot error. However, physical disabilities sometimes do cause a pilot to err.

Basic deficiencies, such as insufficient size or strength, are seldom a cause of error because selection screens out the obviously unfit. Also, temporary illness seldom causes accidents, as sufferers from transient incapacitation are ordinarily removed from flying status until they recover.

In pathological considerations, however, we have a matter of some concern as the following incident shows:

> A 36-year old pilot took off on a cross-country navigational proficiency flight in a two-motor light transport aircraft. He was alone.
>
> Several hours following the take-off, he was observed flying between an overcast, very low, and off his prescribed course. Shortly thereafter, the aircraft crashed and he was fatally injured.
>
> The original impression was that this accident was the result of attempting to fly VFR (Visual Flight Rules) under IFR (Instrument Flight Rules) conditions and, therefore, a violation of flying rules. However, upon post-mortem examination it was determined that he had suffered a "heart attack" caused by coronary occlusion of sufficient magnitude to completely incapacitate him. The accident was, therefore, due to cardiac pathology.

Such cases are unusual in the Air Force due to the young age group and to careful, periodic, physical examinations. But it is of interest to reflect on the role of pathology in civilian flying, especially as aircraft become more and more a businessman's vehicle.

Physiological Tolerances

The influences of physiology on pilot performance is of vital concern. In modern flying, and particularly in high altitude flight, man enters a realm which is enormously hostile to his physiological well being. The upper reaches of the sky are attended with low oxygen tension, low barometric pressure,

Col. H. G. Moseley

Director of Flight Safety Research, USAF

Excerpts from paper "Human Factors that Cause Aircraft Accidents."

. . . . but the pilot is not often at fault.

Problem is a challenge to designers, producers, medics, USAF supervisors, and many others.

and cold, which if allowed to influence the pilot, would greatly complicate his ability to think or act correctly. These factors remain a cause of human error and, when encountered in high performance flight, are attended with a disturbing incidence of fatalities. A significant number of the Air Force undetermined accidents are probably due to hypoxia. In this respect, flying is dependent upon the mechanisms which preserve a livable environment. When these fail, flight fails.

Psychological or Behavioral Variances

Psychological or behavioral variances account for a majority of all unsafe pilot acts. Strangely, we also find that this area is the least understood.

Behavior Aberrations

Because the more bizarre behavior becomes, the more obvious it becomes, true psychotics are a negligible source of aircraft accidents. They are recognized and removed from flying before they can do harm to themselves or others.

Psychoneurotics also are usually eliminated either during entrance screening or pilot training. If a neurosis becomes manifest in a trained pilot, he frequently realizes that he has a problem and seeks medical advice. Otherwise, his roommate or superior will see that he has a problem and refer him to a flight surgeon.

Of somewhat greater concern are those individuals whose behavior is within the accepted range of normality but whose judgments and equanimity are adversely affected by situational maladjustment, deep personal problems . . . or such things as grievances against commanders or rebellion against the entire military concept.

The more obstreperous of these individuals may be involved in violations of flying rules with resultant accidents. The more preoccupied may miss checkpoints, get lost, and otherwise run into adverse situations which normal care or attention would have prevented. Yet, in spite of the adversities often encountered in military life, such maladjustment causes relatively few accidents.

Here, it is again of interest to reflect on the role of behavior variables in civilian flying. Modern high-performance flight and much future flight is, or will be, intolerant of mental or emotional weakness. The requirement for periodic, thorough physical and mental screening of all who pilot aircraft may increase in magnitude.

Behavior Standards

In behavior standards are found the majority of pilot error accidents. This is because flying is absolutely dependent upon the pilot's ability to:

(1) Perceive his world and cockpit about him and recognize the meaning and significance of what he perceives;

(2) Decide from such observations the course of action which will best guarantee unhampered continuance of his flight;

(3) React in a manner which will not only make the aircraft respond to his decisions, but maintain it in flight and bring it to a safe landing during his preoccupations and distractions.

These fundamental requirements are enormously complicated by the speed of flight. Unlike most terrestrial occupations, flying often requires instant perception, split-second decision, and immediate response. Every observation, decision, and act must be correct because even minor deficiencies may lead to an irrevocable course of action that ends in an aircraft accident. The major reasons why a pilot errs or is inadequate in meeting these fundamental requirements of flying are:

- Inadequate knowledge or experience.
- Application irregularities.
- Attitude irregularities.
- Deficiencies in aids to flying.
- Complications and distractions.

Inadequate Knowledge or Experience. It is not surprising that one of the major causes of human error leading to aircraft accidents is inadequate

knowledge. A pilot ground loops or drops the aircraft in or mismanages his fuel because he has simply not yet learned how to handle the machine.

Of even greater concern is unfamiliarity with the phenomena of space and velocity. Because he is removed from the substantial earth, the uninitiated frequently misinterprets his position in space or becomes disoriented or suffers vertigo. Any one of these can establish a highly destructive course of events. Similarly, until he learns the significance of closing speeds, he may be overtaken by disastrous happenings with startling rapidity. Because of such pitfalls, inexperience is the major cause of pilot error within the Air Force.

Application Irregularities. Deficiencies in either intensity or breadth of attention is probably the second most frequent cause of pilot error accidents within the USAF. Failure to give full attention to flight plans may cause the aircraft to crash into an unanticipated mountain. Failure to constantly monitor instruments and communications will lead to oversights and errors which can cause accidents. The pilot may become so interested in actual or simulated strafing of the ground target that he overlooks his airspeed or altitude.

The definitive cause of attention errors or deficiencies are frequently hard to determine. So, they offer a realm of much additional inquiry to psychologists, flight surgeons, and all those concerned with the bearing of behavior upon vehicular accidents.

Attitude Irregularities. Those individuals who cannot work as a team member or who ignore rules and restrictions, sooner or later become involved in an aircraft accident. Although improper attitudes toward team work and rules are not responsible for a sizable number of errors in the Air Force, there is a phase of attitude irregularity which requires constant watching. Many a seasoned pilot has become a statistic by the simple error of letting his desire to get home compromise his judgment on such items as fuel reserve, weather minimums, and similar factors.

Deficiencies in Aids to Flying. Because flying places man in surroundings that are both alien and hostile, there are certain aids that are absolutely essential to his survival. These are the instruments which inform him of his position in space, of his direction, and velocity. These are his fuel gages, his communications, and his warning signals. They are all the knobs and buttons he must use to handle his aircraft.

There are numerous examples of accidents which happened because of deficiencies in these mechanical things. Pilots have made fatal errors because of altimeters which are difficult to read. Pilots have suffered vertigo when their plane fell off into a spin while they diverted their attention from their instruments to a badly placed radio channel selector. Pilots have had flameouts because of fuel control panels which are confusing. Pilots have flown their aircraft back into the ground while trying to reach half-hidden emergency controls.

These errors are almost 100% induced by design which inadvertently complicated the pilot's requirement for instant and correct perception, interpretation, and reaction.

Complications and Distractions. Flying, particularly during landing and take-off, heavily taxes the pilot's ability to meet its varying and exacting requirements. At such times, complications and distractions may overwhelm him and lead to an accident. The things that cause such diversions can be either mechanical or environmental. When an engine fails, there can be no guarantee of a safe landing, even if the failure occurs over an airfield.

Apprehension over possible runway obstructions has caused many overshoots. Unexpected crosswinds have led to innumerable ground loops. And even tower operators have so distracted pilots that accidents have resulted.

In other words, while completely occupied in setting a multi-ton aircraft down on the first 500 ft of the runway at exactly 142 knots under IFR conditions, the pilot should not be required to analyze the significance of suddenly appearing red cockpit lights, answer irrelevent radio inquiries, or decide whether or not the handbook on power on approaches is wrong. In this respect, the prevention of such complications and distractions falls upon a very wide field extending from the designers of aircraft to supervisors of those who fly.

Supervisory and Maintenance Error

The human factors in supervisory and maintenance error are the easiest to explain. In maintaining an aircraft and supervising those who fly, there are but two basic requirements: (1) know what is to be done, and (2) do it.

But much of our maintenance capability must be shaped from unskilled workers, a quota of lower intelligence norms, and sizable proportion of individuals who are not entirely enthusiastic about their occupation.

Due to the rapidity of turnover and these limitations in aptitude, an optimum level of maintenance experience and job volition is exceedingly difficult, if not impossible, to obtain. So, maintenance errors result. They can be minimized only as design simplifies the task to the educational and skill levels which must be utilized.

Supervisory error, to a more limited degree, is confronted with the same impasse. A sizable number of supervisory errors are made by inexperienced flight leaders and similar personnel who have not yet learned the requirements of their job. Even here, advanced engineering skills are not plentiful and simplification of design is in the interest of aircraft accident prevention.

Many-Sided Problem

All of these human errors present a sizable problem to a great many people. It is a problem for those engaged in the medical and allied sciences; for those who educate, and for those who supervise the flyer. It is a particular challenge to those who design, engineer, and produce aircraft.

Regardless of how high, how far, and how fast man may eventually fly, he himself will not change. And unless his limitations are understood and circumvented, he cannot help but destroy both himself and the fabulous machine he flies.

(For complete paper on which this abridgment is based, write SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Long Stroke Diesel . . .

. . . performs better than short stroke one. This is conclusion drawn from series of tests with Caterpillar diesels.

Based on paper by **K. J. Fleck,** Caterpillar Tractor Co.

BECAUSE of renewed interest in the fundamental dimensions of engines, Caterpillar has conducted a series of tests on diesel engines to determine the effect of changes in bore/stroke ratio on performance.

Seven different one-cylinder engines were designed with as much similarity as possible so that changes in cylinder dimensions would be the major difference. The tests were then run in two series.

In the first series of tests the cylinder block, head, and bore diameter were fixed and the stroke was changed. This gave a set of engines with stroke/bore ratios of 1.03, 1.17, 1.27, and 1.45 as shown in Table 1. Results of the tests were as follows:

1. Actual brake horsepower and torque increased with each increase in stroke.
2. Brake mean effective pressure (and brake horsepower per cubic inch) was highest for the long stroke engine up to about 1800 rpm, and for the shortest stroke at 2400 rpm.
3. More power at a lower fuel consumption rate could be obtained with a longer stroke.
4. Friction was the lowest on the 6.50 in. stroke, 1.27 stroke/bore ratio engine.
5. Torque increase characteristics improved with each increase in stroke.

In the second test series, the stroke and bore were allowed to vary while the displacement remained nearly constant, as shown in Table 2. Results of these tests summarize as follows:

1. When the displacement was held nearly constant, (range of 153 to 161 cu in.) the stroke/bore ratio of 1.30 gave the best performance.
2. The 1.45 stroke/bore ratio engine, while performing well, showed excessive friction and a higher rate of power loss at the high speeds.
3. The shortest stroke engine was both low in friction as well as power, indicating that its overall thermal efficiency was relatively low.

The influence of stroke and bore changes on performance is only one of the factors to be considered in the final design of an engine. The driven equipment requirements of torque and speeds influence or even dictate the design. The engine must be thought of as part of an entire package with consideration given to the machine being driven and the types of transmissions and gear reductions involved. Then it must be tailored to meet these requirements. Because of these and other design considerations, future engines may not be built to conform exactly to the results of these tests. (Based on paper "Some Effects of Stroke and Bore on Diesel Engine Performance," which is available in full in multilith form from SAE Special Publications Dept., 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Table 1—To determine the effect of stroke/bore ratio on performance, single-cylinder diesel engines used in the first series of tests had the cylinder block, head, and bore diameter fixed while the stroke was changed.

Bore & Stroke	Displacement	Stroke-Bore Ratio	Surface-Volume Ratio
5.12 x 5.28	109	1.03	9
5.12 x 6.00	124	1.17	8
5.12 x 6.50	134	1.27	7.1
5.12 x 7.41	153	1.45	5.8

Table 2—In the second series of tests the single-cylinder engines used had a near-constant displacement while the stroke/bore ratio was the main variable.

Bore & Stroke	Displacement	S/B Ratio
5.12 x 7.41	153	1.45
5.38 x 7.00	159	1.30
5.75 x 6.00	156	1.04
6.25 x 5.28	161	.85

Retarders Help Prevent Runaway

As vehicles become heavier, larger, and faster, auxiliary braking devices are needed to help control vehicle speeds, especially when running downhill.

AUXILIARY braking systems are used on some heavy trucks and buses because current automotive brakes are unable to handle the heat generated by frequent stops or prolonged braking during descent of long hills. Friction brakes fade and become unreliable as their temperatures rise. Maintenance costs increase too, due to need for frequent adjustments and new brake linings. A retarder slows a vehicle to the point where the brakes can be expected to take hold without fading. By sharing the braking load, retarders substantially increase the life of brakes and, what's more important, save the brakes for emergencies.

Essentially a retarder is an energy absorber and converter. It takes the kinetic energy of the vehicle's motion, converts it into heat, and dissipates the heat to the atmosphere. Three main types of retarders will be discussed in this article: (1) hydraulic, (2) electric, (3) compression.

The Thompson Hydro-Kinetic Retarder

The principle of the Thompson Products retarder is similar to a stalled fluid coupling or torque converter. The rotor has a semi-toroidal cross section and has a number of vanes set radially in the torus and inclined at 45 deg in the direction of rotation. The stator has a semi-toroidal cross section and also has radial vanes inclined at 45 deg opposing those of the rotor.

Rotor vanes accelerate retarder fluid toward the outer periphery of the stator vanes. As the fluid strikes the stator vanes, it is simultaneously decelerated and redirected toward the inner periphery of the rotor vanes. The liquid in the retarder assumes a vortex motion and increases in temperature because of its variations in velocity. This "working" of the fluid between rotor and stator converts the mechanical driveline energy into heat.

The rotor is designed also to act as a centrifugal pump tending to circulate fluid from the retarder, through a peripheral port, to the heat exchanger and returning it to the inlet port of the retarder. Heat rejected from the retarder circuit is absorbed by the water in the engine cooling system, through a heat exchanger. A portion of the heat generated by the retarder is dissipated to the atmosphere by the retarder itself because its finned aluminum housing is always exposed to the air blast created by the vehicle's forward speed. At a low ambient temperature, this can become an appreciable percentage of the total generated heat.

The system consists of an air valve, loading cylinder, heat exchanger, hydro-kinetic power absorber and the connecting air and fluid lines.

The retarder fluid loading cylinder is between the heat exchanger and the retarder on the outlet pressure line. This cylinder is simply a cylindrical tube capped at both ends and containing a free piston. Control air comes in one end. The retarder fluid is free to enter or leave the opposite end. A spring in the fluid side of the piston tends to keep it at the air end of the cylinder whenever control air is released. A separate air reservoir can be installed with a check valve to insure an air charge to the cylinder even in the advent of a complete air failure on the vehicle. The retarder, load cylinder, and heat exchanger are a closed system sealed from the atmosphere.

The heat exchanger is mounted parallel to the engine. Engine coolant passes through the heat exchanger carrying heat from the retarder working fluid to the radiator.

If the power absorber is mounted on the rear of the differential housing, the rotor is splined to the pinion shaft and it operates as part of the driveline.

Trucks

The stator is cast with the outer housing and is bolted to the rear axle carrier. Torque reaction is transmitted through this housing to the rear axle housing.

If the absorber is mounted on the rear of the transmission, the rotor has *two* semi-toroidal cross sections back to back. The stators face both sides of the rotor and are bolted together to form the housing. They are mounted on the rear of the transmission. The output shaft of the transmission drives the rotor.

In both retarder systems the method of retarding and control is the same. The outside diameter of the torus on the double element rotor is 10.6 in. whereas on the single element rotor it is 12.75 in. with the same power absorbing capacity. The power absorption capacity of this type of unit varies as the fifth power of the diameter, hence a very small increase in working diameter can greatly increase the unit's capacity.

During normal driving when retardation is not required, the retarder is empty of fluid. When the operator desires to retard his vehicle, he moves the handle of an air modulating control valve in the cab. This opens the vehicle's air supply to the loading cylinder. Air pressure moves the piston against the fluid which enters the retarder and begins to circulate within the retarder as well as in the system. The quantity of fluid required for a given kinetic energy absorption rate is inversely proportional to vehicle speed. For example, at 50 mph less fluid is required than at 35 mph. Therefore, as the truck velocity decreases, more fluid may be added to the retarder to maintain a constant rate of deceleration. Within normal decelerating speeds, these conditions occur automatically. As the rotor pumping pressure decreases, the loading cylinder, which is under constant pressure, forces

THIS ARTICLE is based on papers presented at a Symposium—Latest Developments on Vehicle Retarders:

"Thompson Retarder"

by J. H. Booth and E. J. Herbenar
Thompson Products, Inc.

"Eddy Current Retarder"

by J. G. Oetzel
Warner Electric Brake and Clutch Co.

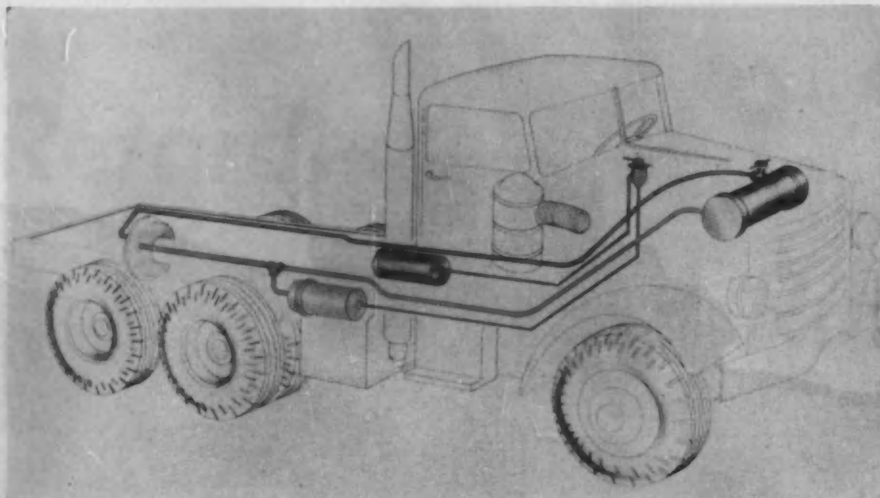
"Compression Retarder"

by W. E. Meyer
Pennsylvania State University

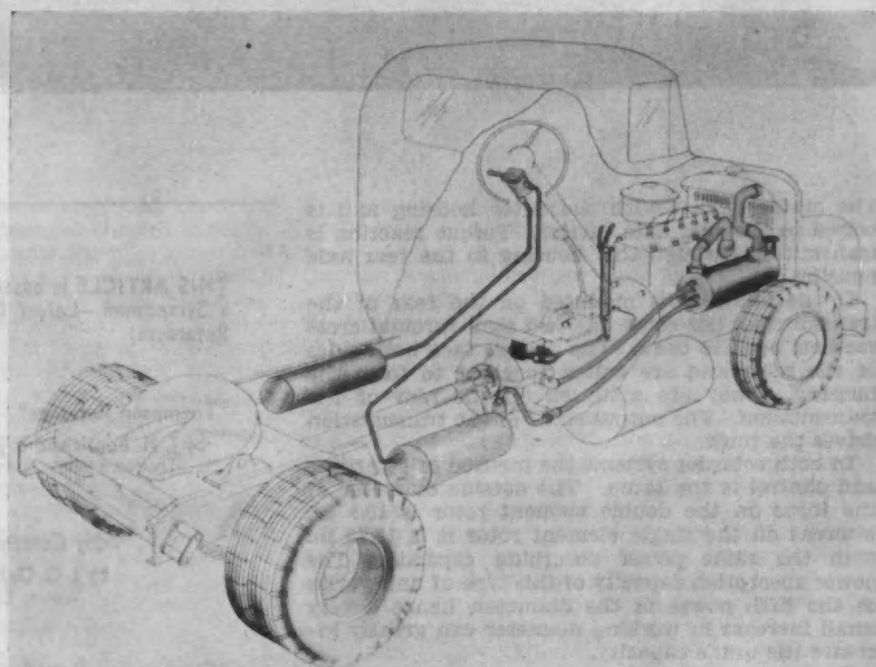
"Hydrotarder"

by E. F. Speiden
Parkersburg Rig and Reel Co.
Division of Parkersburg-Aetna Corp.

Each of these four papers is available in full in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ each to members; 60¢ each to nonmembers.



THOMPSON PRODUCTS hydrokinetic power absorber system mounted on the rear face of the differential housing of a tandem axle truck.



THOMPSON PRODUCTS hydrokinetic power absorber system mounted on the rear of the transmission.

more fluid into the system. Because of this characteristic, the unit is designed for adequate braking at lower speeds.

If the retarder begins to absorb more than the desired amount of energy, the pumping pressure will exceed the air control pressure which will cause the piston to move back, allowing fluid to leave the retarder system with a corresponding reduction in retarding force. Thus, by regulating the air pressure used for loading, any degree of retardation may be obtained. When retardation is no longer required, air pressure is removed from the cylinder and the combined action of the return spring and the retarder's pumping action forces the piston back, thus drawing all the fluid from the retarder back into the loading cylinder.

The retarder can be used for normal highway deceleration such as approaching towns, traffic, and other conditions which require a vehicle to slow up without coming to a stop. It is impossible for the retarder to stop the vehicle completely because as the vehicle speed decreases to zero the retardation power absorbed becomes zero.

The Parkersburg Hydrotarder

While the Thompson retarder uses a closed hydrokinetic system, the Parkersburg Rig and Reel Co. Hydrotarder uses an open system.

Both faces of a rotor and the inside face of two

stators have radially-arranged, triangular-shaped pockets separated by sloping walls. The slope of the walls of the rotor pockets is the same direction as the slope of the adjacent stator pocket. When the unit is filled with fluid, appreciable resistance to rotation is created for one direction of rotation; that is, in the direction opposed to the slope of the pockets.

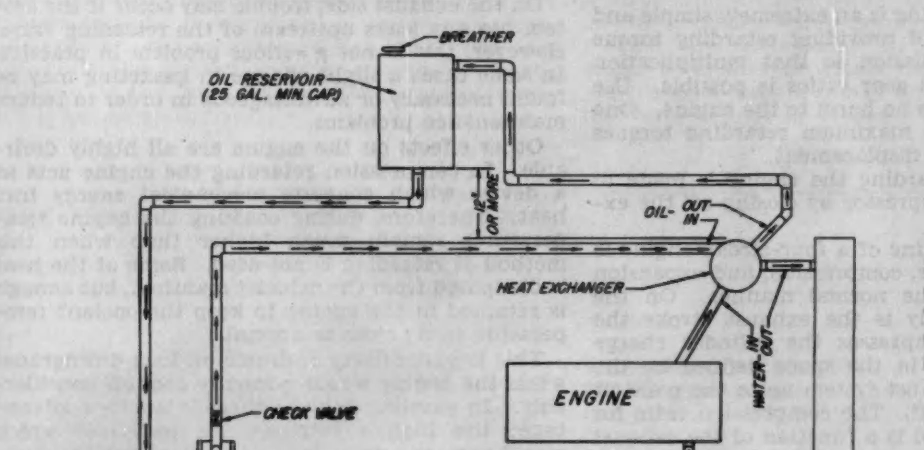
With the rotor in motion, the fluid in the pockets is caused to circulate between the rotor and stator at high velocity. This flow is continually interrupted by the passing of the pocket walls, creating turbulence and heat.

The Hydrotarder has a fluid circulating system that continuously withdraws heated fluid from the unit and adds cool fluid into it. Thus, the hydrotarder is actually a fluid friction device which absorbs kinetic energy of the moving vehicle.

The type of circulating system installed with the Hydrotarder depends upon whether oil or water is used as retarding fluid and the conditions under which the vehicle will operate.

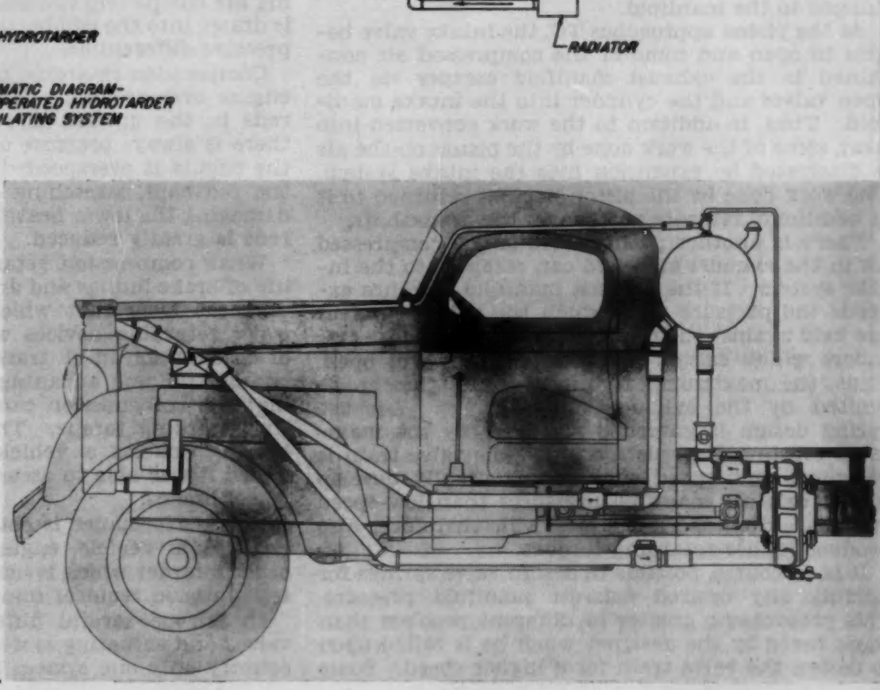
The water system shown in the accompanying illustration is perhaps the most universal. The surge tank is connected to the engine cooling system which permits the dissipation of heat through the radiator. When the vehicle is descending a grade, the radiator is dissipating very little heat from the engine; therefore, the majority of the radiator capacity may be used to dissipate the heat generated within the Hydrotarder. Thus, the Hydrotarder can be applied for relatively long periods without overheating the water.

There is a fluid control valve in the fluid inlet



SCHEMATIC DIAGRAM-OIL OPERATED HYDROTARDER CIRCULATING SYSTEM

PARKERSBURG HYDROTARDER oil circulating system. Oil permits the use of higher fluid temperatures than water.



PARKERSBURG HYDROTARDER installation with typical water circulating system. A surge tank is connected into the engine cooling system. Thus, heat generated by the Hydrotarder is dissipated through the radiator.

line by which the driver may cut off the circulating fluid from the retarder when the braking action is not desired. When descending a grade, the control valve is opened sufficiently to cause enough retarding action to maintain a safe speed. The further it is opened the more braking action there is.

The power absorbing capacity of the 15" Hydrotarder varies approximately with the cube of the speed. For example, maximum capacity at 935 rpm is 100 hp; at 1870 rpm the capacity is 730 hp. Thus the resistance offered by the retarder as speed increases is considerably greater than the increase in the vehicle's kinetic energy as it increases speed. This "speed governing" action will operate whether the retarder is full or partly full of fluid.

Compression Retarder

Compression retarding is an extremely simple and inexpensive method of providing retarding torque ahead of the transmission so that multiplication by the use of various gear ratios is possible. Use has shown that it does no harm to the engine. One drawback is that the maximum retarding torques are limited by engine displacement.

In compression retarding the engine is made to operate as an air compressor by closing off the exhaust manifold.

When the exhaust line of a four-stroke engine is blocked off, the intake, compression, and expansion strokes proceed in the normal manner. On the stroke which normally is the exhaust stroke the ascending piston compresses the cylinder charge again, but this time in the space defined by the cylinder and the exhaust system up to the point at which it is blocked off. The compression ratio for this process is low and is a function of the exhaust manifold volume if we assume the shutoff valve is flanged to the manifold.

As the piston approaches TC, the intake valve begins to open and some of the compressed air contained in the exhaust manifold escapes via the open valves and the cylinder into the intake manifold. Thus, in addition to the work converted into heat, some of the work done by the piston on the air is dissipated by expansion into the intake system. The work done by the piston but not returned to it is additional retarding torque on the crankshaft.

There is another path by which the compressed air in the exhaust manifold can escape into the intake system. If the exhaust manifold pressure exceeds the pressure with which the exhaust valves are held against their seats, the valves of those cylinders which are on the intake stroke will open. Thus, the maximum exhaust manifold pressure is limited by the exhaust valve springs. Because spring design is governed primarily by the maximum rotational speeds for which the valve train is designed, high-speed engines will usually develop higher exhaust manifold pressures than low-speed engines. High-speed engines will, therefore, also produce higher retarding torques.

It is, of course, possible to design valve springs for holding any desired exhaust manifold pressure. This presents no greater or different problem than those faced by the designer when he is called upon to design the valve train for a higher speed. Some European engine builders have used this approach in getting increased retarding torque.

The reversals of flow in the engine intake system, which are caused by having one cylinder take air out of it and another returning it, give rise to one problem: the oil in an oil bath air cleaner may be blown out of it. If this trouble occurs the intake system pulsations can readily be attenuated by providing additional volume between filter and engine. The more cylinders the engine has, the smaller this problem is; and with the use of a dry filter, it disappears completely.

Some discharge of fumes may occur from the intake, even if the fuel supply is completely cut off, because the air picks up some oil vapor on its passage through the engine. Actually this is not significant if the intake system pulsations are sufficiently attenuated so that little back flow through the air filter takes place.

On the exhaust side, trouble may occur if the system has any leaks upstream of the retarding valve. However, this is not a serious problem in practice. In some cases a slight change in gasketing may be found necessary or advantageous in order to reduce maintenance problems.

Other effects on the engine are all highly desirable. In compression retarding the engine acts as a device which converts mechanical energy into heat. Therefore, during coasting the engine temperatures remain much higher than when this method of retarding is not used. Some of the heat is dissipated from the exhaust manifold, but enough is retained in the engine to keep the coolant temperature fairly close to normal.

This is particularly desirable on long downgrades when the engine would normally cool off considerably. In gasoline engines there is another advantage: the high subatmospheric pressures which would normally occur in the cylinders during coasting are completely eliminated. Consequently no oil is drawn into the combustion chamber by a negative pressure differential.

Compression retarding also reduces the danger of engine overspeeding. The load on the connecting rods in the upward direction is reduced because there is always pressure above the piston. Even if the engine is overspeeded the danger of distorting the rod caps, stretching or pulling the cap bolts, damaging the lower bearing halfs, or stretching the rods is greatly reduced.

What compression retarding can do to increase life of brake linings and drums is not fundamentally different from that which can be obtained with other retarding devices which give similar values of deceleration in all transmission ratios. There is one outstanding advantage of compression retarding: the transmission can be used for multiplying the retarding torque. Therefore, compression retarding enables a vehicle to descend any grade which it was able to ascend without the use of the wheel brakes.

This performance is obtained without any major changes in vehicle, engine, or transmission. Any other retarder which is inserted between engine and transmission requires some major redesign.

In Europe several different types of retarding valves and actuating systems are in use, but in this country only one system is commercially available

at this time. This system is the Williams Compression Brake manufactured by the Power Brake Equipment Company of Portland, Oregon.

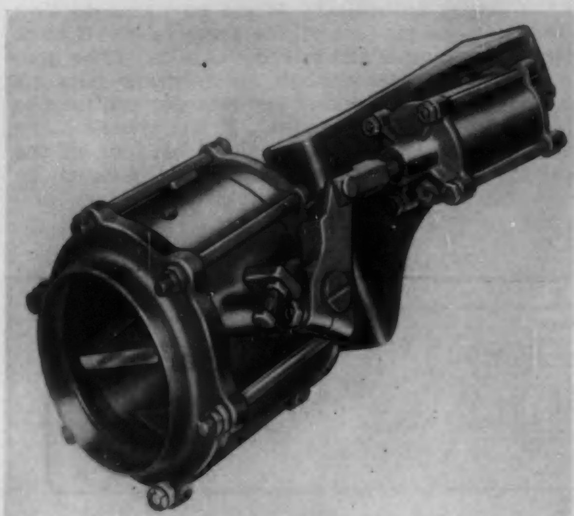
The Williams retarder valve consists of a butterfly valve which is actuated by an air cylinder. The valve is unsymmetrical; therefore, the exhaust manifold pressure produces a torque reaction on the valve shaft. This reaction is balanced by the actuating cylinder air pressure. Consequently, it is possible to obtain any desired amount of retarding by controlling the cylinder air pressure. The valve stop is used to adjust the amount of air passing through the engine when the retarding valve is applied so as to allow the engine to idle without the necessity of opening the valve.

A manual valve controls the air pressure to the actuating cylinder and a gage indicates exhaust manifold pressure. The system has another valve which is actuated by the accelerator linkage and causes the retarding valve to be opened when the accelerator pedal is moved out of the idle position. This prevents the injection of any more than idle fuel while the airflow through the engine is restricted. At the same time it gives immediate engine response on demand.

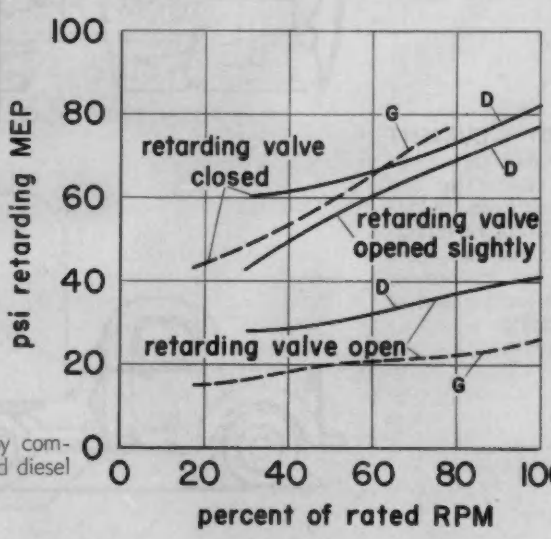
This provision assures safe downshifts. On upshifts the engine still might stall with this arrangement if it were not for the fact that the engine will idle with the retarding valve in the fully applied position. If it were desired to cut the fuel off completely during retarding, a connection between fuel pump rack and clutch pedal would have to be provided to return the pump rack to idle when the clutch pedal is moved and to open the retarding valve.

With either of these arrangements it is possible to leave the control in the maximum retarding position at all times. The driver will then have the benefit of additional retarding torque not only on downgrades, but every time he must slow down for a stop light or a curve. In addition, he can make faster upshifts because as soon as the clutch is depressed the engine will decelerate quicker than it would otherwise. On a downgrade the driver can control vehicle speed by adjusting the air pressure on the retarding valve cylinder.

From an operational standpoint this system seems to answer all likely requirements with one exception: in case of loss of air pressure the retarding valve cannot be closed. When air pressure is



WILLIAMS COMPRESSION BRAKE retarding valve.



RETARDING torque can be more than doubled by compression retarding devices on both gasoline (G) and diesel (D) engines.

lost, compression retarding can be a true life saver: compression retarding with mechanical actuation of the valve is an excellent and economical emergency braking system. However, if mechanical actuation only were used, the functions which the Williams air actuating system provides would have to be performed by mechanical linkages to prevent engine stalling during shifts. The required linkages are, however, not desirable additions to a modern truck.

On gasoline engines there is no need to have airflow through the engine for providing idling with the retarding valve closed because, due to opening the intake manifold to atmosphere, the carburetor cannot deliver an idle mixture. On engines which run with a fairly wet manifold, the manifold dries up during long retarding periods. So, the engine may stall or at least hesitate when the retarding valve is opened and the accelerator depressed. On such engines compression retarding has to be used with care and is, of course, useful only where really long grades must be negotiated and the driver can select the proper gear ratio before starting the descent. With gasoline injection this problem would not exist and operation identical with that of diesels can be obtained.

If the vehicle has a vacuum braking system, the retarding valve will be actuated by vacuum. This presents no problem, but an automatic cutout is needed which opens the retarding valve when the vacuum in the reservoir drops below a safe value.

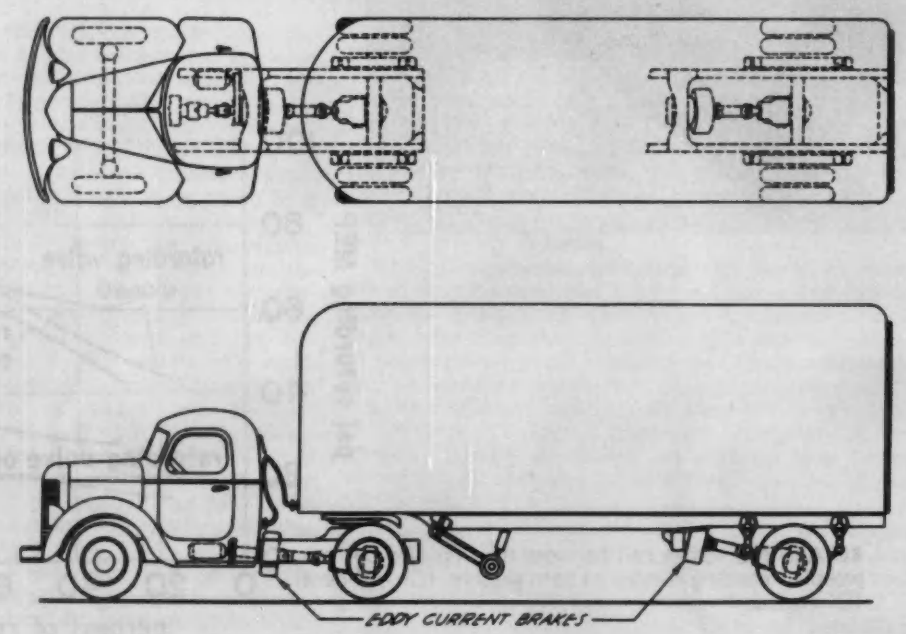
One more important point: the retarding valve can be closed as fast as desired. The retarding torque will always build up gradually since it requires several engine revolutions until the maximum manifold pressure is reached. Thus, no harmful stresses are developed in the drive line; nor is there danger of inducing a skid on an icy road.

Eddy Current Retarder

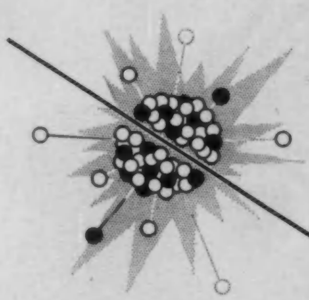
The eddy current retarder makes use of magnetism to slow the vehicle. Essentially it is an electric generator comprising an internal, multi-polar field frame and an external combined armature and fan, mounted on the vehicle's propeller shaft. The armature is a mere shell without windings, in which eddy currents are caused to circulate as it moves past the field poles. Since air can circulate past the armature and the poles, heat generated can be carried off rapidly.

Control is very simple. Current for excitation is supplied directly to the core by a generator that is belt-driven from the propeller shaft. There is a control switch on the accelerator pedal, another on the brake pedal. When the driver's foot is off the accelerator pedal, the retarder cuts in automatically at speeds above 25 to 30 mph. (It is not cut in at lower speeds because it would interfere with gear shifting.) When the switch on the brake pedal is closed, the retarder continues to function as the vehicle reduces speeds, finally going out of action at 10 or 12 mph.

These are the only controls. The driver does "what comes naturally." When he wants to slow down he takes his foot off the accelerator. If he is going over 25 mph, the retarder cuts in. If he does not slow down fast enough, he naturally puts his foot on the brake, making the retarder continue to operate until a lower speed. If the vehicle slows down more than desired, he takes his foot off the brake and puts it on the accelerator. A touch on the accelerator cuts out the retarder.



EDDY CURRENT BRAKES are applied to both drive and trailer axles. By distributing the retarding force thus, there is less chance of jack-knifing and of skidding.



special section on

nuclear energy

The Author

C. R. Lewis
Chrysler Corp.
Chairman
SAE Nuclear Energy Advisory Committee

The effect of nuclear energy on AUTOMOTIVE

RECENT developments in nuclear energy will have greatest effect on automotive engineers and the SAE in the following areas:

- Power generation
- Vehicle propulsion
- Chemical processing
- Engineering materials
- Special components
- Industrial uses of radioactivity

Keeping watch on these areas is SAE's Nuclear Energy Advisory Committee consisting of nine men from the major industrial fields where the most widespread and immediate changes due to nuclear energy are likely to occur. This committee is the focus for the development, collection, and dissemination of nuclear information in the Society and will, from time to time, bring to the attention of automotive engineers, developments which may be of interest to them. The following is a brief resume of recent advances and the state of the art at present.

Cheap power is 10 years off

The most publicized use of energy from nuclei is in the generation of power and heat for application to normal industrial uses. There is, at present, a large nuclear reactor being constructed to operate an electricity generating plant. Other reactors are in the advance planning and development stages. So far, the power available from atoms appears only in the form of heat. (For instance, in an electric plant, the nuclear reactor substitutes for the boiler. If mechanical power is desired, the heat is used to drive a turbine which rotates a shaft.)

In the present state of the art, high temperatures and efficient power producing cycles are not yet available. Therefore, power produced from nuclei is not, at the moment, as cheap as power produced by other means in this country.

Of course, engineers are working to lower the costs and it is expected that in 10 to 15 years nuclear power will be competitive with other power and will be a significant portion of the nation's primary power source.

Since the direct cost of producing electricity is only about 20% of the delivered cost, it is not expected that nuclear power will reduce appreciably the cost of power to the user. However, since one ounce of fuel will produce about 1000 kw continuously for a month, the problem of fuel transportation becomes very much simplified. Nuclear powerplants can be located closer to power users rather than, as at present, close to cheap and easy-to-get fuel.

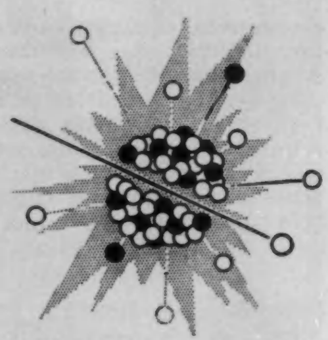
Most of the nuclear powerplants currently being planned are large and capable of producing hundreds of thousands of kilowatts. Smaller plants are not as economical to run but they can be located in regions where present day power costs are higher than average. Small and medium size nuclear power plants look promising for countries where conventional fuels are not readily available.

Nuclear powerplants can be used to produce heat as well as electricity. There is about three times as much demand for energy in the form of heat as there is for electrical power in this country. Estimates are that more than one-third of this heat demand could be supplied effectively by nuclear energy. For example, the steel industry is now studying the possibility of using nuclear heat instead of heat from burning fossil fuels in its furnaces.

Vehicle propulsion is not likely

About 70% of the effort now devoted to the development of nuclear reactors in this country is applied to developing a propulsion reactor. Since it will have immediate military use, the known information is highly classified and unavailable. Undoubtedly many of the developments will be of interest to civilian industry when released.

Reactors have been successfully developed for the propulsion of submarines and are now being built for aircraft and surface naval vessels. Studies indicate that nuclear powered locomotives are tech-



ENGINEERS

nically feasible but, at present, still too costly. Some work is being done on the application of nuclear energy to rocket propulsion.

Unless a completely new and revolutionary scientific principle is discovered, nuclear powerplants will always remain too heavy to power automobiles and trucks. An optimistic estimate of the weight of a nuclear powerplant needed to propel a 3000 lb "atomobile" is 80,000 lb.

If, however, an efficient means of storing energy were invented indirect propulsion of automobiles from nuclear generated power would be possible.

Of more immediate interest to automotive engineers is the increasing need for transportation of highly radioactive fuels and components. This will require heavily shielded vehicles to protect the public from radioactivity. They will also have to be, in some cases, refrigerated to dissipate the heat generated from the radioactivity of the material being transported.

It's been proposed that the standard internal combustion engine could be made to run by nuclear energy. If fissionable material in a gaseous form is put in the cylinder of an engine so that as the piston nears top dead center the material mass becomes "critical," heat will be generated. (Unless a certain amount of nuclear fuel is present in "critical amounts" a self-sustaining reaction generating heat will not take place.) As the piston moves down the cylinder, the concentration of fuel becomes noncritical and the generation of heat will cease. This cycle can be repeated many times before more fuel would have to be added. This concept appears to be technically feasible but not very practical for actual construction and use.

Chemical processing will expand

When perishable food is irradiated it is possible to sterilize it completely so that bacterial spoilage is delayed indefinitely. This pasteurization process will probably have considerable impact on the transportation industry during the next decade. There will be less need for extreme speed in moving perishable foods and less need for refrigerated vehicles.

Of major importance to automotive engineers and the SAE is the use of radiation in processing hydrocarbons. Oil companies are experimenting in forming octane from butane by radiation. Polymerization of some plastics can be induced by radiation. In fact, irradiated polyethylene, which has greater mechanical strength and heat resistance than unirradiated polyethylene, is already in commercial supply. It has also been reported that properties of some silicones can be improved by irradiation. Other plastics, such as the methacrylates are adversely affected by radiation.

Another project presently being studied is the use of nuclear heat to gasify coal at the mine. If it works, the effect on our economy will be immense. It appears likely that the use of radiation in chemical processing will become increasingly important and more widespread.

Engineering materials may be changed

On page 49 of this issue is an article which will cover in more detail the story of materials either required or made available by nuclear energy. Boron, zirconium, hafnium, gadolinium, samarium, and plutonium are some of the elements that are no longer laboratory curiosities. As an example of their potential, hafnium carbide is reported to have the highest melting point of any material discovered.

Due to sodium's use in the atomic energy fields, more is becoming known about it. This will encourage more widespread use for non-nuclear purposes where its low density, and viscosity, high thermal and electrical conductivity, and large heat transfer coefficients may be utilized.

Special components are a new industry

Nuclear reactors at present require highly specialized equipment. Pumps, control mechanisms, measuring instruments, solid fuel elements, remote handling equipment, and all types of machinery for converting heat into power must be devised. Or

conventional equipment may be adapted to nuclear use. In either case, it seems likely that a large industry supplying special apparatus and auxiliary equipment to the nuclear energy field will develop. For example, pumping liquid metals for cooling reactors is essentially the same as pumping liquid type metal in a linotype machine. So the standard liquid metal pump used with linotype machines can be adapted with only minor changes to circulate liquid metal coolants in nuclear equipment.

Industrial applications

The area which has most widely affected automotive engineers until now has been the use of radioactive isotopes in research, development, and inspection. Radioactive tracers are being used to determine wear in metal cutting tools, to trace elements in metallurgy, to measure piston ring and gear wear in automobiles, to measure thickness of combustion deposits in engine cylinders, and to study petroleum refining practices.

Radioactive materials are used as energy sources for measuring instruments. About 300 companies in this country are using radioactive materials as a cheap and convenient substitute for X-ray machines in radiography. Radioactive gages are finding wide application in the measurement of thickness, mass, and density in the rubber, textile, paper, tobacco, and metal industries. The Atomic Energy Commission estimates that work now being done by the use of radioactive isotopes would cost industry an additional $200,000,000 annually if it were performed by other methods.

Other articles in this special Nuclear Energy section of the SAE Journal will go into more detail about the present situation and the future possibilities of nuclear energy in the automotive industry. We feel that the Society, its members, and the automotive industry in general will, as the future unfolds, become more and more involved in the products and byproducts of this new science.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

The effect of nuclear energy on

Petroleum and Petrochemicals Industries

E. Duer Reeves
Executive Vice-President
Esso Research and Engineering Co.

THE use of gamma rays to produce petroleum specialties and valuable petrochemicals will probably be the first important manufacturing application of nuclear energy within the petroleum industry. This development could take place within a few years, at least on a semi-commercial scale, as the result of intensive research by oil firms.

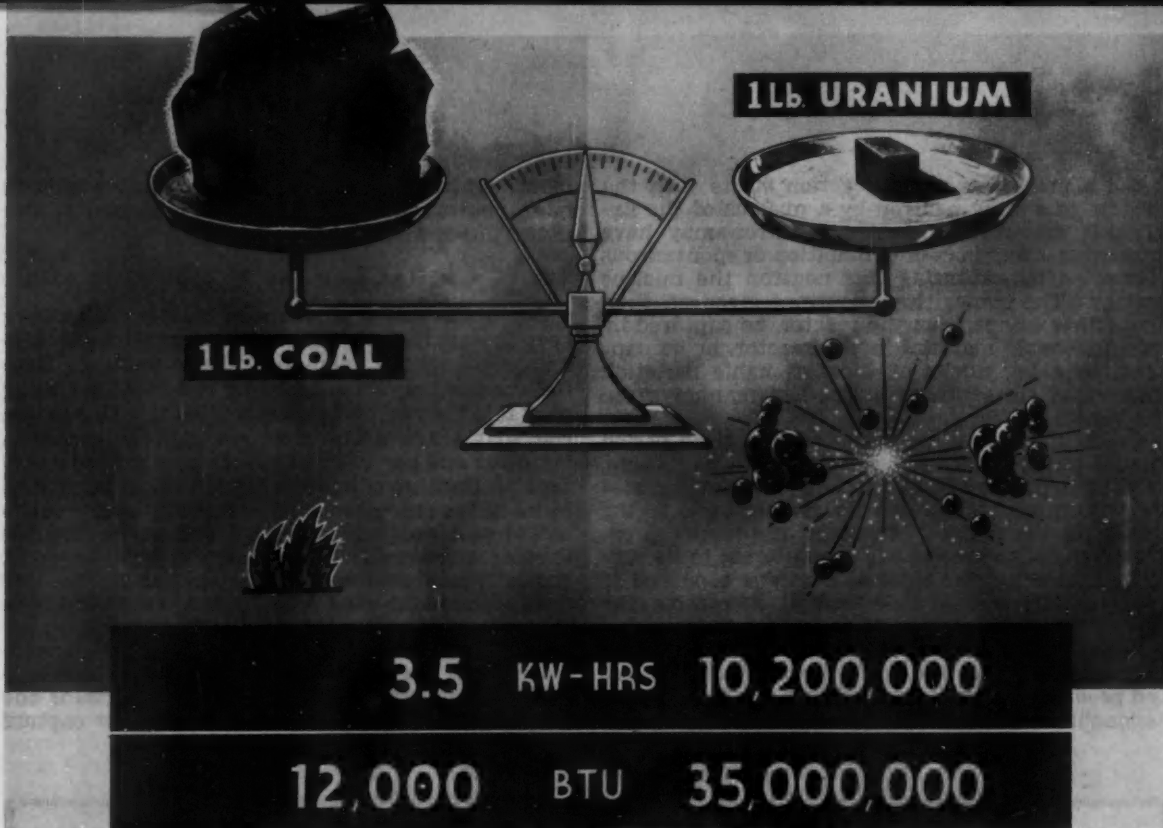
A number of attractive applications can be anticipated from these studies in the field of specialties and petrochemicals because, in addition to gamma radiation from radioisotopes, so-called machine radiation is also a promising device. This technique, utilizing electron accelerators, has already been used in high polymer treating. It is best adaptable to processing surfaces or thin films because high speed electrons, unlike gamma rays, have limited penetrating power.

The petroleum industry is already one of the largest industrial users of radioisotopes. These versatile, accurate tools are used in refining and chemicals research, in engine wear studies, in controlling and measuring operations, and in numerous tracer applications, such as in pipelines.

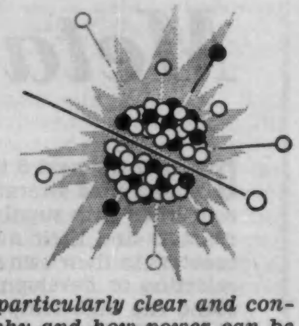
It seems likely that the use of radioisotopes in crude oil production will be expanded, not only in exploration but also in learning more about the behavior of crude oil deep underground.

There is the intriguing prospect that within five to ten years radiation may become part of actual petroleum refining. Early experiments in laboratories have shown that petroleum products such as gasoline can be produced with the aid of either gamma radiation, or nuclear radiation from reactors. Whether this new dimension of atomic energy can be put to work feasibly and economically remains to be seen during the next several years. The prospects are encouraging.

E. DUER REEVES IS A MEMBER OF THE SAE NUCLEAR ENERGY ADVISORY COMMITTEE



The POWER of the ATOM



FOR THOSE who want to "brush up" on their atomic knowledge, here is a particularly clear and concise explanation of why and how power can be produced from nuclear fission.

N. J. Bifano, ANP Department, General Electric Co.
Based on paper "Nuclear Power in Transportation."

THE power produced in a nuclear reactor results from the fissioning of material such as uranium-235 and plutonium-239. When an atom of this material captures a neutron, it splits into two fragments and neutrons, gamma rays, and beta particles are emitted. Each of the fragments has a weight equal to approximately one half the weight of the original atom. However, the mass of material that remains after fission is less than that present before the process took place. The difference is equivalent to the energy that is released in the process. The energy released in the complete fissioning of one pound of uranium-235 is about 35 billion Btu, almost three million times the energy released by burning a pound of coal.

Most of the energy released in fission, about 83% of it, appears as kinetic energy in the fission fragments. The remainder appears as radiation energy and kinetic energy in the other particles that are released. The kinetic energy of the fission fragments is converted into heat by the collision of these fragments with each other and the surrounding structural material required to contain them. Therefore, most of the nuclear energy obtained from fissionable material in a power-producing reactor is in the form of heat.

How a Reactor Works

A nuclear reactor may be assumed to be a homogeneous spherical body which contains fissionable material and passages for the flow of a heat transfer liquid. Usually it contains, in addition, a material

called a moderator. The reaction starts with the capture of a stray neutron by a nucleus of the fissionable material. The stray neutron may have originated either in cosmic radiation or spontaneous fission. After capturing this neutron the nucleus fissions. The two or three neutrons given off then may either escape from the reactor, be captured by non-fissionable material in the reactor, or be captured by other nuclei of the fissionable material. Those that are captured in the last manner cause new fissions.

The neutrons that are produced in a given period of time in a reactor are proportional to its volume, and the neutrons lost to the non-fissionable material within the reactor are also proportional to the volume of the reactor. However, the neutrons escaping from the reactor are proportional to its surface. Therefore, the ratio of neutrons produced to neutrons lost can be increased by increasing the volume-to-surface ratio. This can be done by increasing the size of the reactor. When the size of the reactor is increased to the point where the loss and production of neutrons balance out, the mass of fissionable material contained is called the critical mass. By increasing the size of the reactor further, more neutrons will be created than those lost and useful power may be produced.

Moderating the Reactor

One of the major problems of reactor design is to keep the amount of fissionable material required to an acceptably low value. Leakage of neutrons from the reactor may be reduced by reflecting neutrons back into the reactor by surrounding it with a material that scatters but does not capture neutrons. Graphite and beryllium oxide are good reflector materials. Capture of neutrons by non-fissionable material in the reactor may be reduced by avoiding the use of materials which have a strong tendency to capture neutrons. This cannot always be done, though, because some of the materials that are most suitable for use as reactor structure have high capture cross-sections.

The effectiveness of a given amount of fissionable material in the reactor can be increased by introducing a moderator. A moderating material is one that has a low atomic weight and a low capture

The effect of nuclear energy on the

Metals Industry

E. C. Bain
Vice-President
Research and Technology
U. S. Steel Corp.

DURING the next 5 to 10 years, as well as one may judge from unclassified literature, the metals industries will be more concerned with supplying materials of construction for nuclear reactors and their auxiliary equipment than with using such reactors in their own operations. The chief problem will be the selection or development of cheaper metals which will withstand the high temperatures, pressures, and above all, atmospheres of high neutron density encountered in reactor service.

There is available now a considerable, though far from complete, body of basic information and some direct experience to help meet demands for higher temperature and pressure; but knowledge of the nature of radiation damage and of its long-term importance is fragmentary and unsystematized. Programs designed to provide more reliable and more extensive data are now underway so that within a few years we can expect to have a better understanding of this subject which is of such vital importance to the development of a nuclear power industry.

Another pressing problem is that of corrosion and the effects of mass transfer, particularly in systems in which liquid metals are circulated. In view of the current trends in reactor design, the development of more resistant metals is becoming somewhat urgent.

In their own operations, the metals industries will probably, during the next few years, make increasing use of small amounts of radioactive sources in such applications as radiography and in instruments such as thickness gages. Typical examples are the measurement of rate of diffusion, particularly self diffusion, in solid metals and the rate of wear of metallic surfaces.

Finally, but by no means of least importance, it is clear that the use of radiation under controlled conditions will also provide a valuable tool for exploring many of the fine details of the structure of metals.

E. C. BAIN IS A MEMBER OF THE SAE NUCLEAR ENERGY ADVISORY COMMITTEE

cross-section for neutrons. Because of its low atomic weight, a neutron striking it loses a relatively large portion of its energy in each collision. Because of its low capture cross-section, it does not capture many of the neutrons that strike it. After neutrons are thus slowed down or moderated, their capture by the fissionable material in the reactor becomes much more probable, since the cross-section for the capture of low-energy neutrons is higher than that for high-energy neutrons. Typical moderators are graphite, ordinary water, heavy water, and beryllium oxide.

Controlling the Reactor

A nuclear reactor, in principle, can be controlled quite simply. One of the most direct means of control is to arrange a neutron absorbing rod so that it can be inserted into the reactor or withdrawn from it. If the rod is withdrawn from the reactor, it will absorb a smaller number of neutrons than before. If, in its original position, the rod was absorbing that number of neutrons which held the power constant, then withdrawal of the rod will create a slight excess of neutrons in the reactor and the power will begin to increase. If, for example, we withdraw the rod so that the number of the neutrons absorbed in fission is 0.1% greater than before, then the number of neutrons in the reactor will increase by 0.1% in each neutron generation. Since the neutron generation time is extremely short, the reactor will build up power fairly rapidly.

When it is desired to stop this build-up, the control rod is inserted to its original position. This will deprive the neutron cycle of its 0.1% excess, and the power of the reactor will stay steady at the new level thus reached. Similarly, if it is desired to decrease the power of the reactor, inserting the rod more deeply than its original position will enable it to absorb more neutrons than before, and the chain reaction will gradually die.

Other methods of control have been proposed, also. For example, in a reactor which has a reflector, removal of part of the reflector will allow the leakage of more neutrons than before. This will decrease the reactivity. Also, removal of part of the moderator or some of the fuel itself from the reactor will decrease the reactivity. These methods may be used as control mechanisms.

Shielding the Reactor

Radiation given off in fissioning is very harmful to both people and certain materials. The gamma rays and neutrons require appreciable thicknesses of shielding materials to provide protection against radiation, but the beta particles are easily stopped by relatively thin sheets of metal. Gamma rays interact primarily with electrons and therefore are stopped best by dense elements of high atomic number such as lead. Since neutrons are more readily absorbed at low energies and can be slowed down most effectively by light atoms such as hydrogen, water is a very good neutron shield.

The seriousness of the shielding problem is obvious. The radiation escaping from an unshielded reactor producing sufficient heat to generate the electricity required to keep a 100-w light bulb burning is several million times larger than the radiation

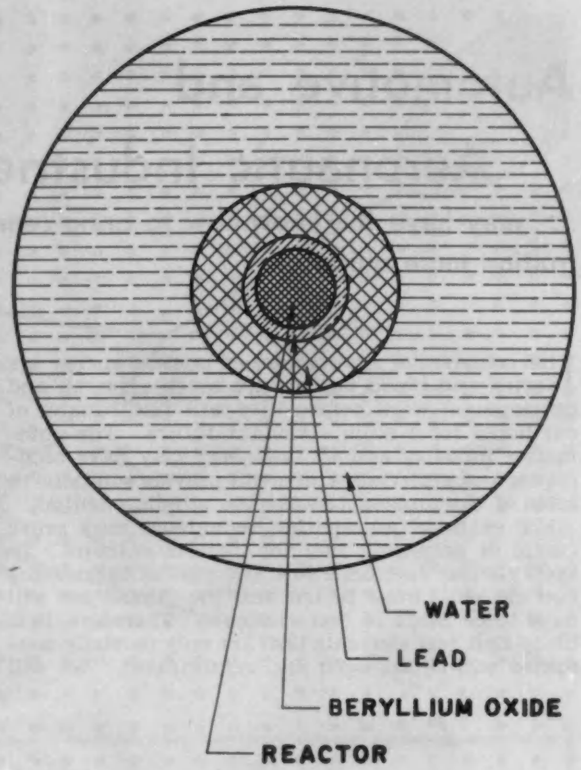
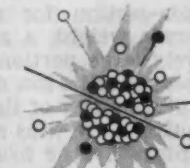


Fig. 1—Nuclear reactor theoretically may be considered a sphere surrounded by shields of beryllium oxide, lead, and water.

exposure considered life-time safe to people. This safe exposure can be compared with a commonly known yardstick: the amount of radiation absorbed during fifteen 24-hour days under this exposure can be considered equivalent to the radiation absorbed in one diagnostic X-ray. Shielding a reactor so that people close to it are not harmed by radiation is a formidable problem, particularly when the weight of shielding material must be kept at a minimum, as in mobile reactors.

Let's assume that the reactor is a sphere and that it is surrounded by spherical shells of beryllium oxide, lead, and water, as shown in Fig. 1. The beryllium oxide shell serves as a neutron reflector and reduces the number of neutrons that escape from the reactor, thereby reducing the amount of fissionable material required to maintain suitable radiation levels. The lead and water shells serve as shielding for the gamma rays and neutrons, respectively. As the reactor heat output is varied by a factor of 1000, the weight of shielding varies only by a factor of 4 For this reason, although nuclear power is ruled out for small mobile powerplants by shielding weight, it can be applied to advantage in large powerplants where the weight of shielding is relatively small and very large quantities of fuel can be eliminated.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)



Automotive and Aeronautic Industries . . .

. . . may have the know-how to bring commercial applications of nuclear energy into fruition more quickly.

Based on paper by **U. M. Staebler** U.S. Atomic Energy Commission

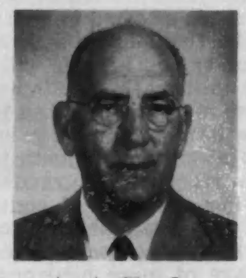
THE commercial applications of nuclear energy are varied and broad but require much research and development work before they will fulfill many of our hopes for a more abundant future. The automotive industry and its engineers may have techniques and materials which will provide solutions to some of the problems facing the atomic scientist.

For example, automation techniques may prove useful in preparing fuel for nuclear reactors. To keep nuclear fuel costs low, the cost of fabricating fuel elements must be low and the utmost use will have to be made of fuel elements. Therefore, it is likely that fuel elements that are only partially consumed will be salvaged and refabricated. We will need inexpensive techniques for processing and refabricating radioactive fuel elements by remote control. If these costs are no higher than 1 mil per kw-hr, we will be able to tolerate between $10 and $30 per lb uranium costs.

Since the fission process develops extremely high temperatures, there is a need for materials that can withstand them. The automotive industry may be able to give us considerable help in this area, too.

(Based on paper "A Survey of the Peaceful Applications of Nuclear Energy," which is available in full in multilith form from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

The effect of nuclear energy on Engineering Materials



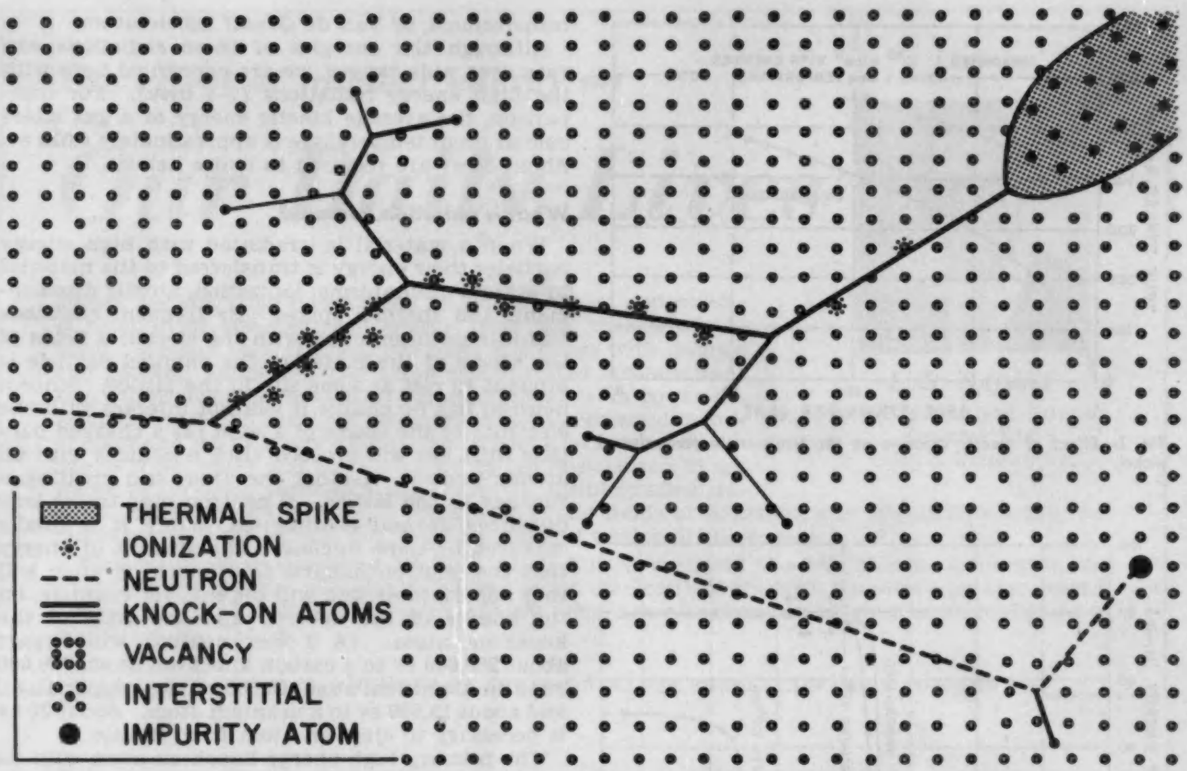
A. A. Kucher
Director
Scientific Laboratory
Engineering Staff
Ford Motor Co.

INTENSE sources of radiation of the order of a billion curies will soon be available from nuclear reactors and the spent fuel elements of nuclear powerplants. We can expect a significant increase in the use of this radiation to produce new engineering materials and processes of value to the automotive industry.

Although at present it's not clear what economic advantages will accrue from using radiation to change the properties of all common engineering metals, the effect of radiating non-metals, particularly polymeric materials, appear potentially good. It is likely that by "radiation grafting" two different polymers together it will be possible to accentuate the most desirable properties of each. For example, by grafting a chemically inert material that has excellent heat resistance to a more adhesive polymer, a copolymer may be produced that can be applied easily as a protective coating.

Radiation may also be used to modify surface properties of materials, especially those materials used as catalysts. Significant changes in the oxidation properties of graphite when irradiated have already been noted. Undoubtedly, scientists will continue to study the effects of radiation on combustion processes and on the physical properties of metals.

A. A. KUCHER IS A MEMBER OF THE SAE NUCLEAR ENERGY ADVISORY COMMITTEE

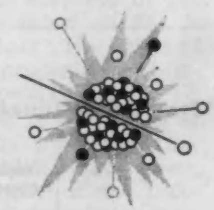


RADIATION PARTICLES traversing a solid produce vacancies, ionization, interstitials, impurity atoms, and thermal spikes—all of which are responsible for changes in the material's properties. Whether the change is beneficial or damaging depends upon the material and the type and intensity of radiation.

How Radiation Changes Materials

Michael Ference Jr., Ford Motor Co.

Based on paper "Effects of Radiation on Materials."



RADIATION can produce significant changes in the properties of materials. Most plastics degrade rapidly in intense radiation fields; however, polyethylene improves its properties under moderate radiation. Many metals increase in hardness, ultimate tensile strength, and yield strength, but decrease in elongation, and show very small changes at room temperature in density and creep rates. Carbon steels show an increase in fracture-transition temperature. Gamma radiation in organic chemical systems breaks chemical bonds and forms free radicals, initiating polymerization and starting chemical chain reactions. Often radiation-produced polymers are superior to catalyst-produced polymers. It is also possible to "radiation-graft" one polymer onto another.

What is radiation?

There are several types of radiation: alpha particles, which are helium nuclei with a double positive charge; beta particles, which are negatively charged electrons; gamma rays, which are electromagnetic waves of photons with no charge and negligible mass; energetic protons, which are hydrogen nuclei with a single positive charge; and neutrons, which have no charge and a mass nearly that of the proton.

Radioactive isotopes from nuclear reactors and spent reactor fuel elements are useful sources of this radiation. Radiation may also be produced in high energy accelerators such as cyclotrons, betatrons, synchrotrons, linear accelerators, resonant

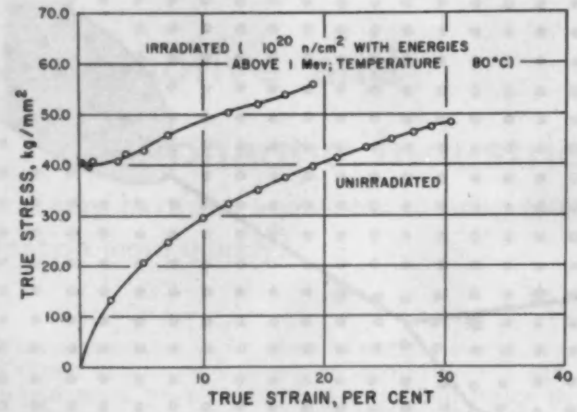


Fig. 1—Effect of reactor exposure on the stress-strain properties of nickel.

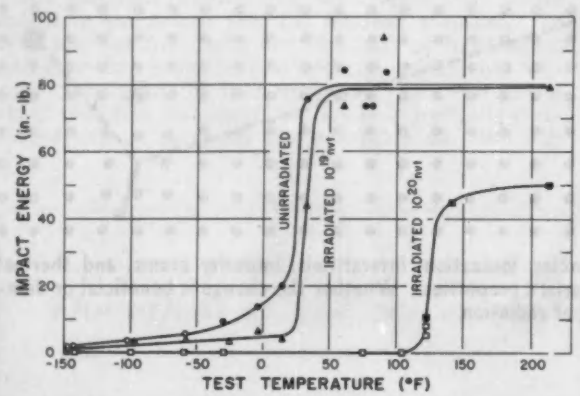


Fig. 2—Effect of radiation on the notch-impact properties of normalized carbon-silicon steel. The temperature of ductile-to-brittle fracture increases with increasing irradiation.

Pre- and post-irradiation hardness, yield strength, and tensile strength.

	Rockwell Hardness No.		Yield Strength 10^3, Psi		Tensile Strength 10^3, Psi		Ratio of Yield Strength: Tensile Strength	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
2SH14 aluminum	8F	40F	18	23	20	27	0.9	0.85
2SO aluminum	—	—	7	17	17.3	26	0.51	0.65
High purity iron	—	—	18	31	36	37	0.5	0.84
Normalized carbon steel			50	93	75	97	0.67	0.96
Hardened and tempered alloy steel	—	—	153	196	164	198	0.93	0.99
Austenitic stainless steel	81B	99B	37	97	98	115	0.38	0.84

transformers, or Van de Graaff accelerators.

Although the energies of these radiations can vary over wide ranges, we are concerned here with the high energy radiations (1–5 mev). For comparison, the average kinetic energy of a gas molecule at room temperature is approximately 0.025 ev. About 24 ev are required to ionize helium.

What is radiation damage?

When a material is irradiated with high energy particles their energy is transferred to the material by several mechanisms: ionization, atomic displacement, and thermal spikes. By frequent collisions and intense interaction with the electrical fields of the atoms of the material, the charged particle is brought to rest at some site in the lattice. Since a neutron has no charge it will not interact with the electrons of the atoms of a solid (as a charged particle will) but will proceed until it collides with an atomic nucleus, ejecting the atom and creating a vacancy in the lattice. A neutron may travel long distances, several centimeters, before it is finally captured by some nucleus. The amount of energy that the neutron imparts to a knock-on atom will vary considerably and will depend, for example, on the energy of the neutron and the mass of the knock-on atom. (A 2 mev neutron will impart about 280,000 ev to a carbon knock-on atom, 130,000 ev to an aluminum atom, 60,000 ev to a copper atom, and about 15,000 ev to a uranium atom. About 30 ev is necessary to eject an atom from its site.)

The primary high energy knock-on atom with its accompanying electronic field strongly interacts with the other atoms of the lattice and produces intense ionization along its path. A large part of the energy of the moving particle is lost in this way. In addition, the knock-on atom can collide elastically, displacing more atoms from the solid which, in turn, displace atoms in a cascade process until the energy of the knock-on atoms appear as thermal energy of the solid. The various displaced atoms lodge as interstitials within the lattice, provided they do not immediately fill a nearby vacancy.

The neutron that is finally captured by an atomic nucleus may render the nucleus radioactive and subsequently eject impurity atoms into the lattice. For example, if the material contains some boron-10,

Effect of radiation on ASTM A-212 grade B carbon-silicon steel.

	Yield Strength 10^3, Psi	Tensile Strength 10^3, Psi	Reduction of Area Pct	Uniform Elongation, Pct, to Necking
Unirradiated	50	75	64	22
Irradiated 10^{19}nvt at 140°F	65	81	68	18
Irradiated 10^{19}nvt at 570°F	57	84	57	12
Irradiated 10^{20}nvt at 175°F	94	97	26	5

The effect of nuclear energy on

Our Daily Lives

L. R. Hafstad
Vice-President and Director
Research Staff
General Motors Corp.

SOME decades from now we will be generating an appreciable fraction of our electrical energy from the nucleus of the atom. We will be sterilizing our food and drugs with gamma and neutron radiation. Our large concentrated business centers will probably be heated by byproduct heat from power-developing reactors. Airplane fields will be kept permanently free of snow and ice by reactor heat. The present increasing shortage of fresh water will be eliminated by the distillation of sea water, again using byproduct heat from the disintegrating nucleus. Small scale applications of isotopes in the fields of medicine and industrial testing, too numerous to mention, will aid in the health and wealth of the nation.

Who would have predicted in 1885, when Edison designed the first bi-polar generator, the enormous dependence of today's civilized world on electrical energy? To even a greater degree, nuclear energy will change the world of 2000. One's imagination can be given unlimited scope in predicting the future.

L. R. HAFSTAD IS A MEMBER OF THE SAE NUCLEAR ENERGY ADVISORY COMMITTEE

absorption of neutrons by the boron will create unstable nuclei. They will disintegrate and produce energetic helium and lithium nuclei which, in turn, will eject other atoms from the material.

Energy from a fast knock-on atom may be transmitted to many atoms near the path of the oncoming particle, setting up intense localized lattice oscillations. This results in the formation of a thermal spike, a region of localized heating. Calculations indicate that several thousand atoms may be raised to temperatures near 2000 K for about 10^{-10} sec. In this short time interval, it is assumed that melting and some turbulent flow occur. It has also been suggested that strains in the surrounding areas of thermal spikes would produce dislocation rings. Radiation apparently can induce dislocations in materials.

Such defects produced by radiation in solids are responsible for the changes in the materials' properties.

How radiation affects metals

In metals, these radiation defects serve as scattering centers for electrons, causing changes in the electrical and thermal conductivities of the material. Also, dislocation formation and movement will affect the mechanical properties. Ionization effects are not important in metals, but in nonmetals they lead to bond fracture and free radical formation.

Although radiation defects produced by neutron bombardment of metals are confined to more or less small areas, rather significant changes in the mechanical properties can occur under accumulated attack of the order of 10^{21} nvt. (The symbol nvt is used to denote time integrated neutron fluxes representing the amount of bombardment in neutrons per square centimeter.) Many metals increase in hardness after irradiation, increase in ultimate tensile and yield strengths (particularly if the temperature of bombardment is low compared to the melting point), and decrease in elongation. Most metals show very small changes in density and creep rates at room temperatures.

Some of the significant changes observed in the stress-strain curves of nickel are shown in Fig. 1. This is representative of most metals. The effect of irradiation on the notch-impact properties of normalized carbon-silicon steel is shown in Fig. 2.

The permanency of the changes in properties of the crystalline solids produced by irradiation depends upon the temperature at which it took place, subsequent annealing, and the value of the integrated irradiating flux. Metals heated above their recrystallization temperature, for example, show no permanent effects.

Although the mechanisms of radiation effects are understood there is no satisfactory quantitative theory available for engineering calculations. Also, except for a few materials, there is a lack of experimental data on the effect of intense radiation on metals. Broadly speaking, large neutron doses (10^{20} nvt) will increase hardness of carbon steels about 40%, stainless about 100%, nickel about 140%, and zirconium about 100%. Ultimate tensile strengths have been increased about 10% in carbon steels, 20% in stainless, 40% in nickel, and 5% in zirconium. So far, there is no experimental evidence that radiation will produce beneficial changes in the

bulk properties of metals that cannot be obtained by conventional metallurgical methods.

Effects of radiation on nonmetals

The degree of damage and the resulting changes in physical properties of nonmetallic solids under equivalent irradiation are much greater than for metals. In organic solids the effect of bond breaking and ionization caused by radiation is quite important.

The physical characteristics of the refractory nonmetallic solids are influenced by the degree of ionic and covalent bonding and the type of structures of the crystals of the ceramic matrix. Most of the studies of ceramic materials have been confined to the effects of neutron bombardment of the crystal components of the ceramic.

Those crystals that are characterized by covalent bonding appear to be most susceptible to dimensional changes on irradiation. Quartz shows a density decrease of 14.7% for an exposure of 2×10^{20} nvt. The unaltered quartz lattice is a network of linked tetrahedrons of SiO_4. Two bonds need to be broken to displace an oxygen atom and four bonds to displace a silicon atom. In addition, oxygen atoms need be displaced only a short distance to find an interstitial hole. In quartz the internal structure becomes amorphous under intense exposures, but interestingly enough no microscopic defects such as cracks or bubbles were observed. About 1500 C is required to anneal this lattice damage appreciably in the single crystal. The effects on the oxides of beryllium, aluminum, and zirconium are similar though less severe. The oxide of beryllium is the most stable.

In diamonds a density decrease of 4% can be obtained for a neutron irradiation dose of about 10^{21} nvt, indicating that a large number of atoms is displaced. Clear crystals of diamonds become black after an irradiation of only 10^{17} nvt. The damaged structure will recover some 70% of its density change on annealing for 2 hr at 1600 C.

Under intense irradiation the crystal lattice of graphite is significantly distorted, with an eventual destruction of the crystal into an amorphous form. The distortion is due to the expansion of the interplanar dimensions of the lamellar structure by the displacement of carbon from normal positions in the lattice. The result is a marked change (though not necessarily deleterious) in the physical, mechanical, and electrical properties of graphite. Some of the mechanical properties are improved; for example, compression strength can be doubled. Irradiated graphite produces a tougher, harder graphite which is somewhat more difficult to ma-

The effect of nuclear energy on

Marine and Rail Transportation

Ray McBrian
Director of Research
The Denver and Rio Grande Western Railroad Co.

DESPITE the emphasis on large power reactors, research into smaller reactors capable of being applied to land or marine transportation is progressing. Even though less money is being spent on these projects there may come, within the next 5 to 10 years, small power reactors that can be used successfully in boats and possibly in some forms of land transportation.

Typical projects: The Army has awarded the Nuclear Development Corp. a $100,000 contract to study the feasibility of atomic engines for inland waterways and harbor craft, railroad equipment, and very large overland cargo carriers for use by the Army Transportation Corps.

The Denver and Rio Grande Western Railroad and Baldwin-Lima-Hamilton Corp. have given a contract to the Walter Kidde Nuclear Laboratories for continued development of a closed cycle reactor featuring a free piston linear electric generator hermetically sealed, using a fissionable gas as a fuel. Preliminary studies indicated the principle is theoretically sound. The contract calls for a feasibility and economic study to determine the merits of an oscillating piston reactor powerplant for locomotive or package use.

Such studies will certainly develop more creative and imaginative thinking, which is most necessary to speed marine and land transportation atomic power research. Despite the problems to be overcome the future is most promising.

RAY McBRIAN IS A MEMBER OF THE SAE NUCLEAR ENERGY ADVISORY COMMITTEE

chine. The thermal and electrical conductivities decrease with radiation.

Radiation energizes chemical reactions

Nuclear radiation can also be used to bring about chemical reactions in solids, liquids, and gases.

In evaluating the usefulness of radiation for chemical reactions it is necessary to know not only the amount of radiation available but also the efficiency with which radiation can be used to initiate reactions. The criterion used as an efficiency index is the g value of the reaction. It can be defined as the number of free radicals or chemical bonds modified for each 100 ev of energy absorbed. The g values vary over a wide range depending on the nature of the radiation. For example, for benzine, g is about 1; ether, about 17; acetone, 40; cross linking of solid polyethylene, about 3; and for certain chain reactions, g can have values of many thousands.

The dosage applied to a chemical system is measured by the amount of energy absorbed per gram of material irradiated. The unit of dosage is the rad which is equal to 100 ergs per g. At radiation doses of 1000 megarads (10^9) polyethylene becomes glass-like.

Because of the relatively low g values of many reactions and hence low potential output, the use of radiation for conventional synthesis does not appear feasible except for rather special cases. In the case of chain reactions induced by radiation such as polymerization and chlorination, the economics are more favorable.

Conventionally, polymerization of monomers is initiated by the presence of highly reactive chemical radicals promoted by some type of catalyst. Gamma radiation will break the chemical bonds of organic substances and form free radicals, thereby starting a chemical chain reaction and polymerization. One of the advantages of radiation-induced polymerization is that free radicals can be produced at almost any temperature and in either the liquid or solid phase, whereas chemical polymerization generally requires high temperatures. Radiation-produced polymers are often superior to catalyst-produced polymers. For example, radiation produced polyethylene is more crystalline and tougher. Also, polymerization of ethylene is a chain reaction with g values of about 12,000.

It is possible to radiation graft one polymer onto another in such a manner as to control the properties of the grafted copolymer.

If a polymer A_n, such as polyethylene, is added to a monomer B, such as methyl methacrylate, and the mixture irradiated, part of the monomer B will polymerize as polymer B_m and part as a grafted copolymer A_nB_m. By the proper choice of experimental conditions it is possible to increase the formation of the grafted polymer at the expense of the polymer B_m. Radiation grafting may be carried out on finished or semi-finished materials. The technique of combining in a controlled manner the physical properties of two different polymers has considerable practical interest. For example, the surface characteristics of polytetrafluoroethylene, an extraordinarily inert polymer, may be altered considerably by introducing "grafts" of polyacrylonitrile at intervals along the chain. The new material exhibits increased adhesive properties and displays pronounced reactivity.

The mechanical properties of long-chain molecules in the form of a solid can be greatly modified by exposure to radiation. Irradiation of thermoplastics may result in cross linking of the polymer chain or may result in cleavage of the main chain and hence degradation of the material. In some materials a fissure of side chains may also take place. Not many cross links per chain are required to make important changes in properties. For example, one additional bond per 2000 carbon atoms will change the properties of polyethylene. Polymers such as polyethylene and polystyrene are cross linked on irradiation. Polymers such as polytetrafluroethylene and polymethyl methacrylate are degraded by fission of the carbon-carbon bonds.

Normal polyethylene can be cold drawn. It begins to soften at about 70 C, becoming a viscous liquid at about 115 C. After irradiation with doses of about 50 megarads, cross linking takes place transforming it partly into a three dimensional network. As a result, instead of becoming a viscous liquid on heating, the polymer takes on rubber-like elastic properties; that is, it becomes an elastomer. Both the tensile strengths and elastic moduli increase. At very high doses (1000 megarads) the polymer becomes glass-like.

Polystyrene requires 50 times the dose of polyethylene to start cross linking due to the presence of the benzene ring in styrene. Such a side chain ring stabilizes many organic compounds against radiation damage.

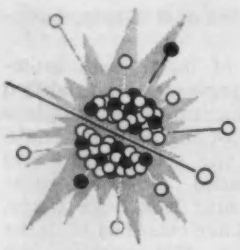
In polytetrafluoroethylene even light irradiation tends to fragment the chain, producing short random chains that eventually evolve as CF_4. Polymethyl methacrylate degrades rapidly under light doses of less than 1 megarad.

Vulcanization of rubber by radiation

Vulcanization changes the natural rubber polymer from a soft, sticky, plastic to a non-plastic highly elastic substance. A single rubber molecule may consist of several thousand monomers (C_5H_8) joined end to end. The change in properties by vulcanization is brought about by cross-linking these long rubber molecules by the presence of sulfur. The cross-links are relatively few, about one per several hundred monomer units. The cross-linking of the long rubber chain can also be induced by radiation with gamma rays without the presence of sulfur. Here the cross-linking is between carbon atoms rather than through sulfur-sulfur atoms. Bonds between the carbon atoms are stronger than those between sulfur atoms and it is expected, therefore, that radiation vulcanized rubber would be more heat stable than sulfur-vulcanized rubber. The smearing temperatures for gamma ray vulcanization of rubber and carbon black are about 500 F as compared to 400 F for ordinary vulcanizates.

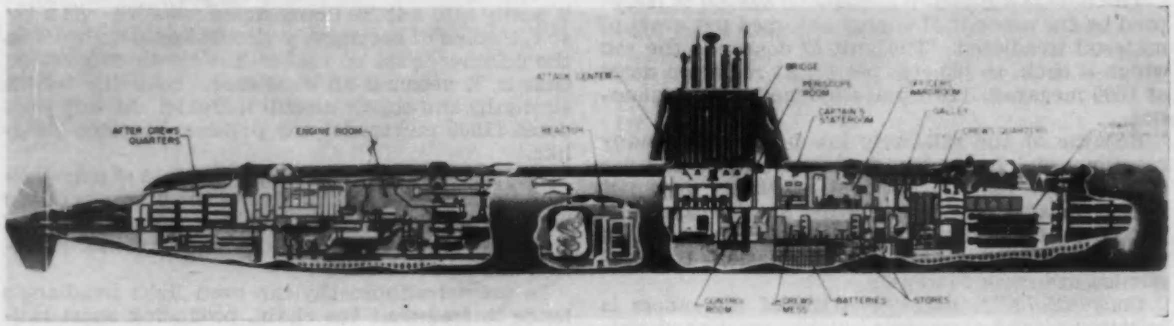
To obtain good cures by radiation cross-linking, rather large (50 megarads) doses are necessary. Because of this very low g value, it is rather costly.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

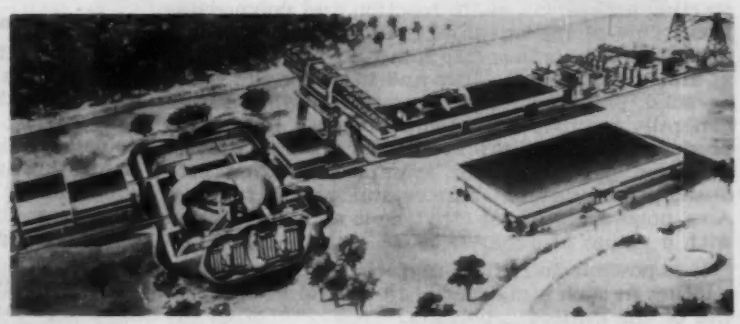


THE EMBRYOS of nuclear powerplants are rapidly taking form in this country today. With the operation of these plants will come inherent radiation hazards. We are all aware of the dangers associated with uncontrolled radiations. Here, however, are descriptions of some of the safeguards our nuclear physicists and scientists have come up with to prevent the release of radioactive material should a reactor accident occur.

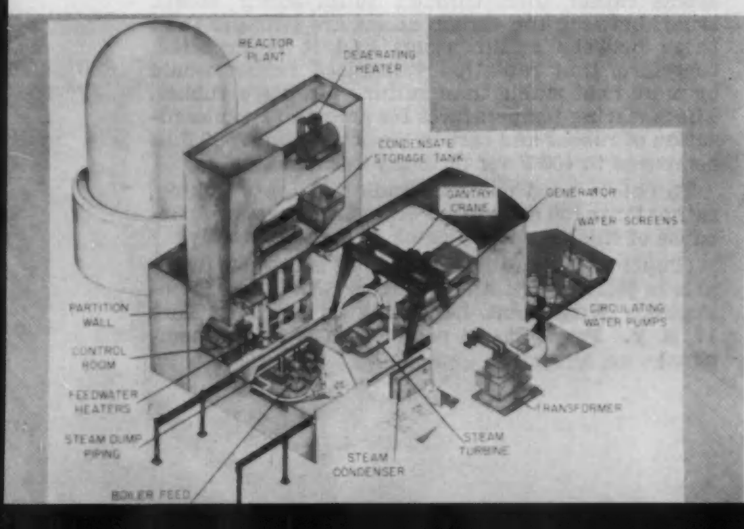
Water, Steel, and Protect Against



The Nautilus is an outstanding example of the concept that a containment structure can be built around a reactor to prevent the release of radioactive material following a reactor accident. Here, both the hull of the submarine and the surrounding waters act as containment vessels.



The pressurized water reactor being installed at Shippingport, Pa., is located inside large steel pressure vessels buried in the ground. All components which might contain radioactivity are located in the three underground containment vessels.



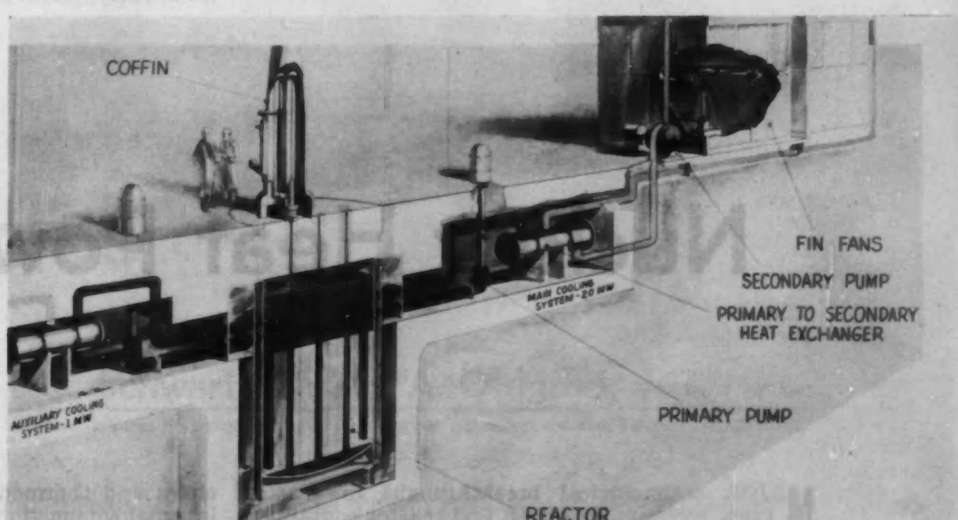
In this steam-electric portion of a typical nuclear powerplant, too, the reactor and other radioactive components are located in a large containment vessel.

Concrete

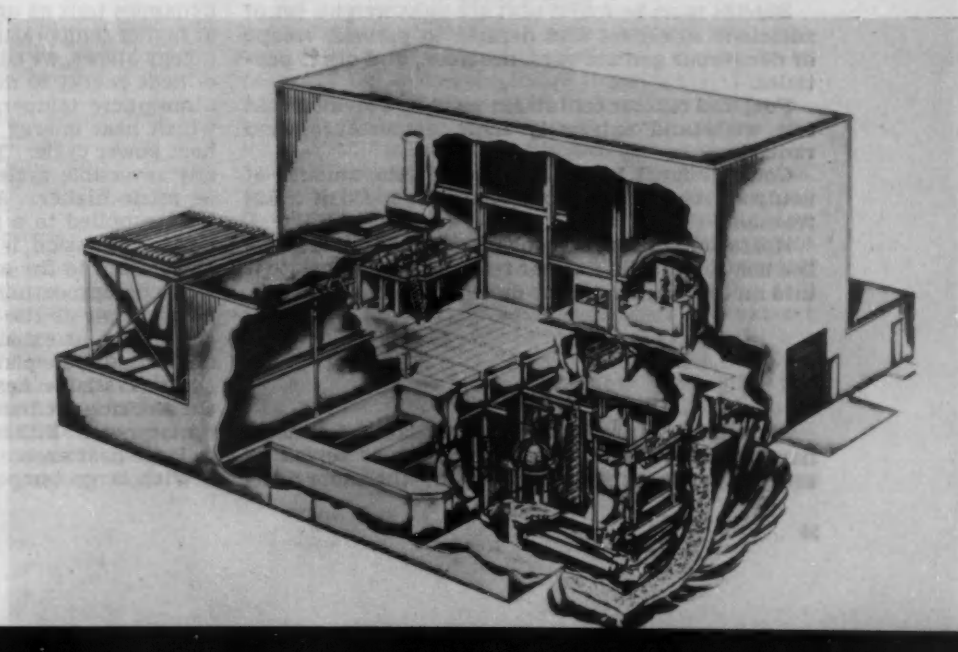
Nuclear Radiation from Reactors

C. R. Russell, General Motors Corp.

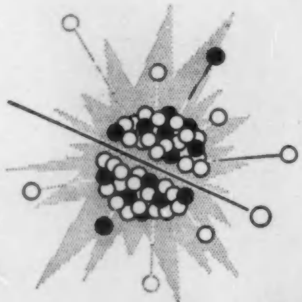
Based on paper "The Safety Aspects of the Use of Nuclear Energy."



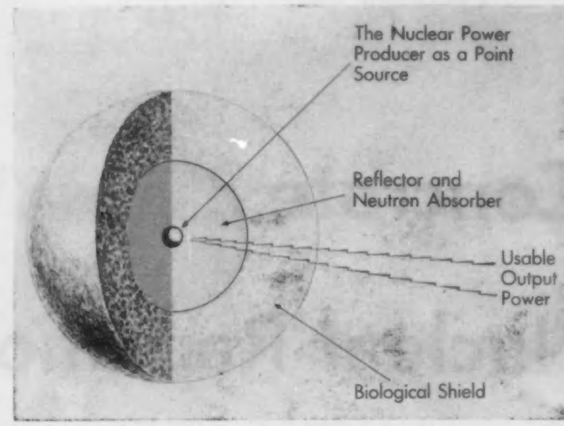
The Sodium Reactor Experiment (a combined effort of North American Aviation and the Atomic Energy Commission) is built in an underground vault designed to contain any foreseeable accident.



The Homogeneous Reactor Experiment No. 2, located at the Oak Ridge National Laboratory, has its reactor located in an underground vault designed to contain any pressure that would result should the system fail. This type of reactor is of particular interest since with a homogeneous system the fuel can be continually processed in a side stream for the removal of fission products. Since the magnitude of the hazard is proportional to the inventory of fission products, this feature is a major advantage for homogeneous systems.



***THE PROBLEM** of developing a practical nuclear powerplant for motor vehicles is two-fold: to harness the heat energy released in nuclear fission, and, at the same time, to devise ways to prevent injury and material damage from radiation.*



THEORETICAL NUCLEAR HEAT ENGINE (assuming the heat source, power extraction device, and neutron shield are a point) would require biological shielding that would give a minimum weight of 12,000 lb. At 20 lb per shaft horsepower, smallest usable power output would be 600 hp.

Nuclear Heat Powerplants

MAJOR technological breakthroughs in reactor fuels, coolants, shielding, and reactor containers are necessary before engineers can develop a practical nuclear heat powerplant for ground vehicles.

Shields must be found that are light weight, yet of sufficient thickness and density to prevent escape of dangerous gamma rays, neutrons, and other particles.

Fuel and reactor containers must be provided that can withstand extremely high temperatures and radiation.

Controls must be devised to limit the amount of neutrons set free so as to regulate the speed of chain reaction.

Heat exchangers and coolants must be able to take the heat out of the nuclear reaction and translate it into mechanical energy to drive the vehicle's wheels.

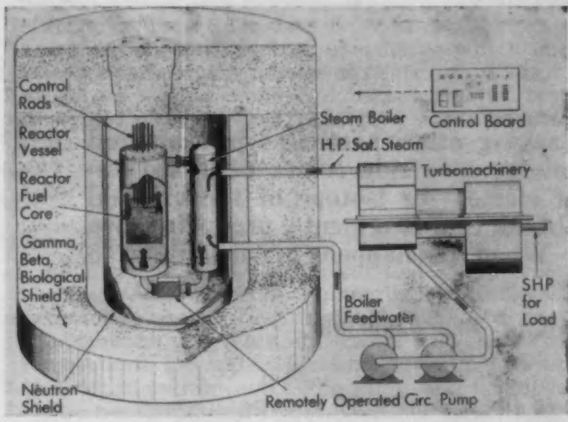
Thermodynamics Still Applies

Although the problems are formidable, engineers have reason to believe that they can be solved by using classic heat power principles—the same principles and thermodynamic laws which govern the internal combustion engine.

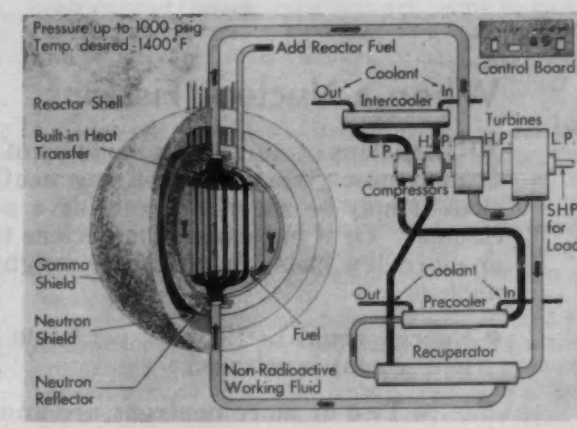
With nuclear fuel as the source of heat energy—just as with gasoline—the Second Law of Thermodynamics tells us unless we can use the heat energy at higher temperatures than present materials technology allows, we can convert only a limited amount of heat energy to mechanical energy. The ambient atmosphere temperature is the lowest practical at which heat energy can be rejected in any kind of heat power cycle. Thus to improve the efficiency of any reversible cycle heat source temperature must be made higher. Actually from 60 to 75% of the heat supplied to a powerplant, whether from combustion or fission, is not converted to work and must be rejected to the atmosphere.

The reciprocating engine and open-cycle gas turbine use air as the working medium and discharge the heat and exhaust to the atmosphere. But in any closed cycle plant, whether using gas or a vapor, the unavailable heat must first be extracted from the working medium before it is exhausted into the atmosphere. Either large temperature differences or large heat exchangers are necessary.

With large temperature differences the heat re-



HOMOGENEOUS LIQUID METAL REACTOR would weigh about 50,000 lb at 20 lb per shp, minimum size of engine would be 2500 shp. Fuel would possibly be U-235 in bismuth; moderators and reflector, carbon; coolant, helium. Neutron and gamma shields are still to be invented.



PRESSURIZED WATER REACTOR would weigh about 100,000 lb. At 20 lb per shp, minimum size engine would be 10,000 shp. At 25% efficiency, heat generation would be 29.8 megawatts. Fuel would be highly enriched uranium; water neutron shield; lead gamma shield.

for Vehicles

F. L. Schwartz and H. A. Ohlgren, University of Michigan

Based on paper "Automotive Nuclear Heat Engines and Associated High Temperature Materials."

jection temperature is made higher, thereby lowering cycle efficiency. Large heat rejection equipment is bulky and weighty, and therefore undesirable for automotive powerplant systems.

However, if an open-cycle powerplant is used and heat is transferred from the reactor to a working fluid that is unaffected by radiation, these problems may be overcome.

Another equally difficult problem arises from the necessity of constructing enough shielding to give protection from dangerous radiation. This is largely a materials problem.

Unique Materials Properties

Materials used for construction of nuclear heat-power reactors require, in addition to conventional engineering properties such as corrosion resistance, strength, ductility, stress and thermal properties, unique nuclear properties. Whether the material is to be used for nuclear fuel, moderators and coolants, reflectors, control rods, vessels, piping and mechanical equipment, or shielding, it will be subject to interactions with radiation and nuclear particles. Alpha particles, beta particles, gamma rays, and neutrons produce chemical and physical changes in these materials.

Nuclear Fuels

Any mobile nuclear-heat power sources will probably depend upon one of the following materials for fuel: (1) uranium-235 (found in nature); (2) uranium-233 (artificially made by neutron capture in thorium-232); (3) plutonium-239 (artificially made by neutron capture in uranium-238).

Reactor fuel may be in the form of solids, liquids, and possibly gases. Most reactors presently being developed use solid fuels. (Several promising new types of compact design have their fuels in liquid form.) If the fuel is in solid form, the elements may be shaped as rods, tubes, and flat plates. The fuel elements are arranged so that coolants can extract the fission energy in the form of heat energy.

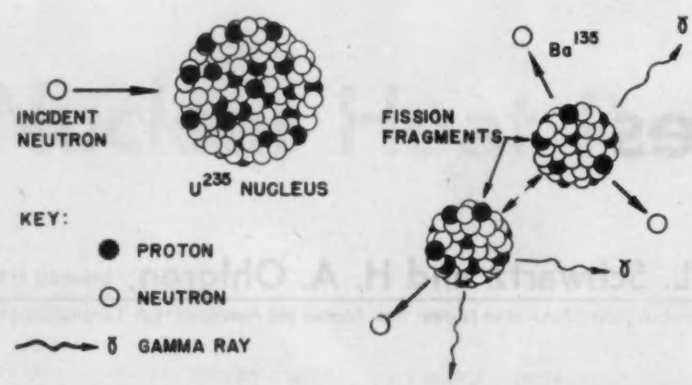
To prevent the fuel element from being corroded by the coolant and to retain highly radioactive fission products in the fuel element, the fissionable fuel is clad or jacketed with materials such as aluminum, zirconium, or stainless steel.

A liquid homogeneous fuel may consist of: (1) an

When a Nucleus Fissions . . .

THE nucleus of an atom is made up of (among other particles) protons and neutrons. When a free-flying neutron from outside comes near the nucleus it may be absorbed, creating a new element or isotope of the original element. Or it may cause the nucleus to break into fragments, producing two or more new elements of lighter weight. When this happens to a uranium-235 nucleus . . .

- **Energy equal to 192 mev per atom (about 30,000,000,000 Btu per lb) is released.**
- **Two or more neutrons are knocked loose and may escape into space or cause further fission in nearby atoms, setting off a chain reaction.**
- **High speed electrons, called beta particles, are emitted.**
- **Gamma rays, which are extremely intense x-rays, are emitted. Gamma rays have high penetrating power and are dangerous to health.**



SCHEMATIC OF REACTOR CORE. Solid moderator of carbon slows down velocities of neutrons so that they can be captured by nuclei of the fissioning fuel elements. Coolants may be water, air, or liquid metals. Control rods absorb excess neutrons and prevent reactor from "running away."

aqueous solution of a fissionable salt; (2) a fused salt in molten form; or (3) a molten metal of the fissionable material or some alloy thereof.

Fuel Elements Are Clad

Reactor fuel elements are units which, when assembled in suitable mass and geometry, have in them a fuel material undergoing fission. Fast neutrons, beta particles, gamma rays, and fission fragments are generated in a fuel element during fission. Materials used for fuel elements must have low neutron absorption cross-sections and minimum changes due to radiation. They must be resistant to oxidation and corrosion. They must have high mechanical strength, high heat capacity, and low thermal shock properties.

Zirconium can serve as a material to clad fissionable fuels. In water-cooled, power-producing reactors, zirconium has desirable properties up to temperatures of 800 F. It is not attacked severely by water or oxygen at high temperatures. Its mechanical properties meet requirements for reactor fuels.

Stainless steels have higher neutron absorption cross-sections than zirconium. The chemical and physical properties of the stainless steels are suitable for power producing reactors. Minor impurities influence these properties.

Moderators Slow Down Neutrons

Moderators are materials which slow down velocities of neutrons so that they can be captured by nuclei of the fissioning fuel. Slowing down is accom-

plished by collisions between neutrons and the moderating material. The best types of moderators are those which have nuclei of masses which most closely approach the masses of neutrons. Thus, hydrogen is a good moderator. Heavy water, beryllium, and carbon are all relatively better moderators from a nuclear viewpoint than light water. Sodium, and sodium-potassium liquid metals are very poor moderators.

Coolants Must Operate at High Temperatures

Heat removal from a nuclear-heat-power source is one of the controlling engineering parameters for automotive nuclear heat engine systems. In reactor development programs underway, the media used for coolants are water, air, and liquid metals such as sodium, sodium-potassium alloy, and bismuth.

The heat produced per unit volume in a nuclear-heat-power unit can be made as high as permitted by maximum working temperatures of construction materials and reactor fuels. Heat transfer surfaces can control the size of a nuclear heat source. Thus, a coolant which has low probabilities for neutron capture must have the ability for good heat transfer and withstand high temperatures.

Neutrons Are Bounced Back

Neutrons produced in the fission process are used in a nuclear-heat-power system for sustaining the nuclear chain reaction and for control. As the size of the nuclear heat source is reduced, the ratio of surface to volume of the critical geometry increases. Thus, the probability of neutrons escaping from the system increases. So, a reflector is used to bounce back some of the neutrons that are trying to escape from critical volume so that they return at the energies required to prompt fission.

Controlling the Reactor

Control of a chain reaction at desired power level is accomplished by controlling neutron absorptions at rates which minimize power surges, but do not shut down the reactor. This is done by controlling the amount of fission at any given time in the reactor by inserting control rods, shim and scram rods, and by controlling the amount of neutron reflection.

Safety and assurance of reactor control are enhanced for thermal reactors since delayed neutrons are produced in sufficient quantities and over long enough periods of time to permit operation of control mechanisms.

Structural Materials Vary

Choice of reactor structural materials depends upon size and type of reactor, the intended service, and operating temperature. Reactors which operate with thermal neutron energies can use only materials with low absorption cross-sections.

Reactors which operate with fast neutron energies permit selection of a wide variety of materials. The economic design of power reactors to operate at high temperatures limits the selection of structural materials.

In regions of a nuclear reactor where neutron intensities are high, expensive materials such as zirconium are required. The vessel containing fuel, moderator, coolant, and reflector materials can be

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The effect of nuclear energy on **AIRCRAFT**

D. R. Shoults
General Manager
Aircraft Nuclear
Propulsion Department
General Electric Co.

NUCLEAR energy will be a key factor in the development of better aircraft. The relatively unlimited energy available from nuclear fuel allows us to disregard fuel consumption in aircraft design. Nuclear power can give us global range and endurance limited only by the crew.

In the past, engine output was limited by the size of the powerplant. Aerodynamic developments led the way in producing superior aircraft. Presently power has become a more important factor in the growth of aircraft design. For subsonic speeds, suitable engines are currently available for most conditions, but fuel consumption limits directly range and utility. For supersonic speeds, there are engines now in use and being developed. However, they are proportionately heavier and consume much more fuel. Future jet engines will be even heavier and may require fuel to be carried outside of the aircraft because of space limitations. Thus, the power required for faster supersonic speeds will be difficult to attain with present type engines. That's why the use of a nuclear reactor in an aircraft will be the key to aircraft design for the next 5 to 10 years and afterwards.

D. R. SHOULTS IS A MEMBER OF THE SAE NUCLEAR ENERGY ADVISORY COMMITTEE

Table 1—Shielding Materials and Thicknesses Needed to Decimate Neutron Intensities

Neutron Energy	Shielding Material	Thickness, cm
1 mev	Hydrogen	8.2
	(in water)	8.6
	Oxygen	13.0
	(in water)	
	Lead	

of more ordinary materials, such as stainless clad carbon steels.

Materials known to engineers today require compromises for reactor size, operating temperatures, fuel inventories, and economic parameters.

Shields Absorb Neutrons

For safe operation of a nuclear-heat-power unit, all neutrons that tend to escape from the nuclear heat source must be absorbed by neutron shields.

Neutron shielding materials must have nuclear properties which "slow down" fast neutrons and absorb slow neutrons. The neutron absorption process generally results in release of gamma rays. Thus, neutron shield materials are located and contained within materials provided for gamma shielding. Some satisfactory neutron shielding materials and the thicknesses of shields needed to reduce neutron intensities to one-tenth the value of incident neutrons are given in Table 1.

Gamma And Beta Shielding

The fission products and "capture" products resulting from fission are highly radioactive. The radioactivity is released in the form of gamma rays and beta particles. Reactors, therefore, must be shielded to protect life.

The absorption of beta particles (high-speed electrons) is accomplished by many materials with relative ease. The only known materials capable of intercepting gamma rays, which are high frequency, short wave electromagnetic waves similar to X-rays but much "harder," are dense materials such as concrete, cast iron, lead, uranium, and thorium.

The greater the power output of a nuclear heat engine, the greater is the mass of shielding matter that must be provided for tolerable health dosages at the surface of a shield.

Even though it might be possible to develop a small light weight nuclear heat source and powerplant the size and weight of necessary shielding materials surrounding the nuclear heat engine would be enormous.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

The effect of nuclear energy on

AUTOMOBILES

J. J. Grebe
Director
Nuclear and Basic Research Department
The Dow Chemical Co.

THE most immediate effect of nuclear energy on automobiles, apart from tools for research, would appear to be the use of radiation to catalyze the setting of polyester fiber glass parts, other paints, and coatings. Even with the limited work done so far, setting times of one minute have been achieved, thus increasing the output of a given mold very considerably.

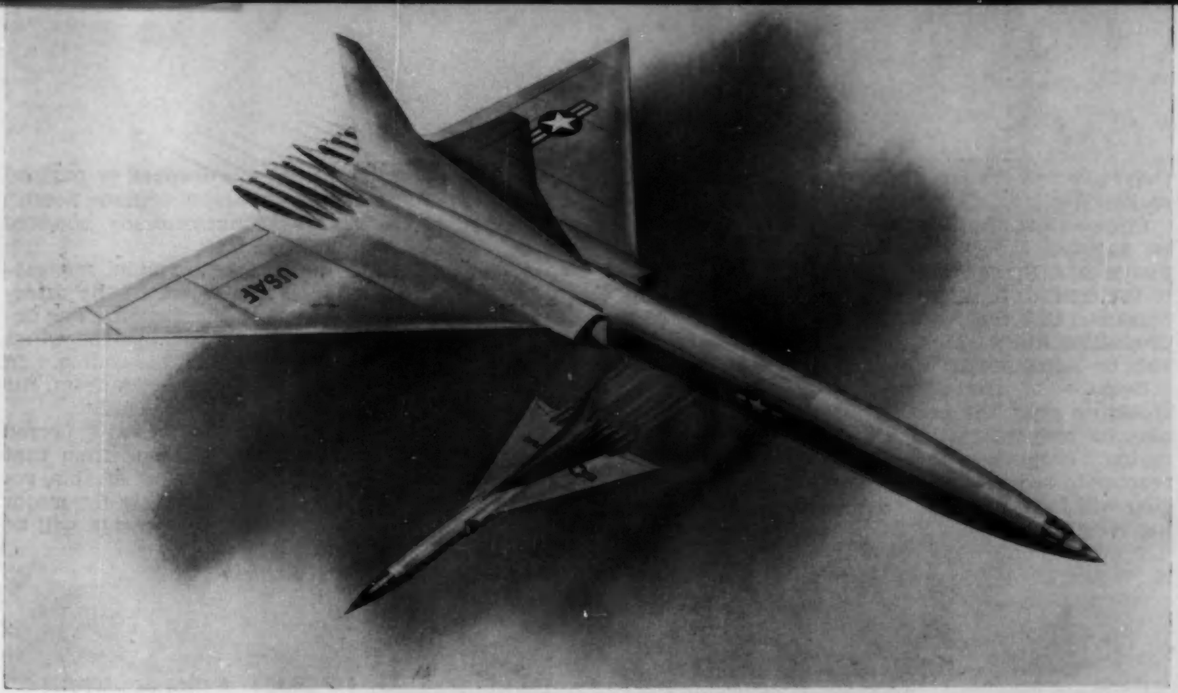
It is also likely that cross-linked polyethylene will find its way into many electrical insulation applications because of its insolubility in gasoline and the very wide range of shapes and forms and elastic properties that will be available.

Another application that must be considered is that, at last, it may be possible to make tough plastic windows scratch resistant by covering the surface with a softer material that will "give" instead of scratch. This can be done with branch polymerization produced by radiation.

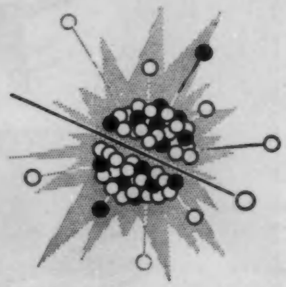
A still longer range application may well be the internal absorption of shocks and vibration in specially designed plastic compositions capable of dissipating the necessary amount of heat and operating through a very wide temperature range.

Way off in the distance one can see a safety car that is so tough, strong and stable, based on the great diversity of materials properly interlinked by radiation, that human injury from accidents will be rare.

J. J. GREBE IS A MEMBER OF THE SAE NUCLEAR ENERGY ADVISORY COMMITTEE



HEAVILY shielded reactors supplying heat to turbojets or turboprops from relatively small amounts of fissionable fuel will give huge size and new operating problems, along with great endurance, to . . .



NUCLEAR-POWERED AIRCRAFT

Lee A. Ohlinger, Chief of Computing Center, Northrop Aircraft, Inc.

Based on paper "Nuclear Power in the Air of Tomorrow."

TOMORROW'S nuclear-powered aircraft will probably look like exaggerated versions of today's aircraft. But their powerplants will endow them with operating problems quite different from those of current chemically fueled aircraft.

The nuclear-powered airplane will be bigger, heavier, longer nosed, faster, able to go farther. And it will require different means of power control, longer runways, new provisions for maintenance.

First nuclear-powered airplanes will use the reactor to supply heat to turboprops or turbojets. Nuclear-fueled ramjets won't be feasible until we have materials able to withstand temperatures much higher than presently known materials can. Nuclear-fueled ramjets must await discovery of new means for converting the energy released from the nuclei of atoms into useful forms other than heat—such as photon pressure, redirected fission fragments, or electricity.

The fission fuel needed to keep the plane aloft practically indefinitely without refueling will weigh only a negligible amount. But 50 tons or so of shielding will be required to protect humans on board and materials and electrical components from harmful radiation. The shielding plus the structure to lift it will put the airplane in the weight class of the largest planes flying now.

First nuclear-powered aircraft off the production lines are likely to be types benefiting most from the endurance potentiality:

- Aerial tankers for refueling jet fighters and other high-speed chemically fueled aircraft limited in range by fuel capacity.
- Transports for fighting men and military supplies.
- Air freighters.
- Search and patrol aircraft.
- Long-range bombers.

(Missiles will logically not be among the first quantity applications because they would involve loss of valuable fissionable material and because

they will require considerable progress in nuclear rocketry.)

Chances are that aircraft for these purposes will be not too different—although larger—from airplanes now flying. The heavy reactor will be close to the center of gravity of the airplanes for balance reasons. One reactor will supply heat to all of the propulsion units. (Individual reactors would probably be below the critical size.)

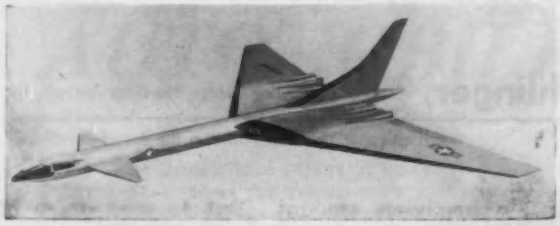
Because of the concentration of reactor and shielding near the center of gravity, the fuselage may be proportionately bigger than usual in that region. Propulsion units may be located nearer the reactor to reduce the travel of hot gases. Landing gear will have to be unusually sturdy because landing weight will be virtually the same as take-off weight (except when bombs are dropped or payload parachuted). The nuclear-powered airplane doesn't lighten itself in flight as conventionally powered planes do in consuming their fuel.

As the captions to the pictures explain, nuclear-powered aircraft are likely to evolve in the direction of the long-nosed delta configuration. The object of extending the nose and pushing the wings aft is to separate crew and radiation source. In general, the greater the distance between them, the less shielding needed.

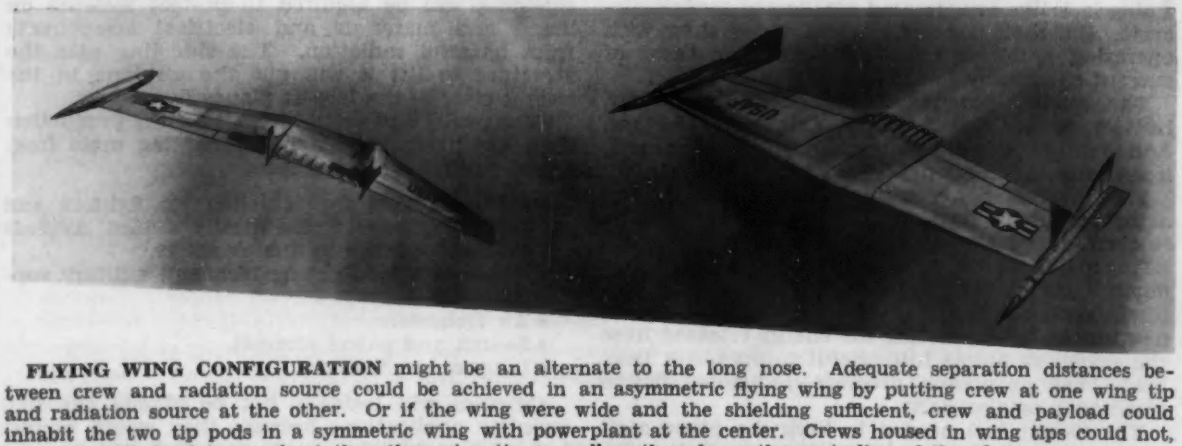
The control of power level in a nuclear-powered engine is entirely different in technique from that of chemically fueled engines. Because of this, reactor control probably will be used only for major changes in power level. Finer adjustments will be

FIRST NUCLEAR AIRCRAFT if they are conversions from conventional aircraft, might have extended fuselage noses like this. Purpose is to get the crew as far as possible away from the source of radiation.

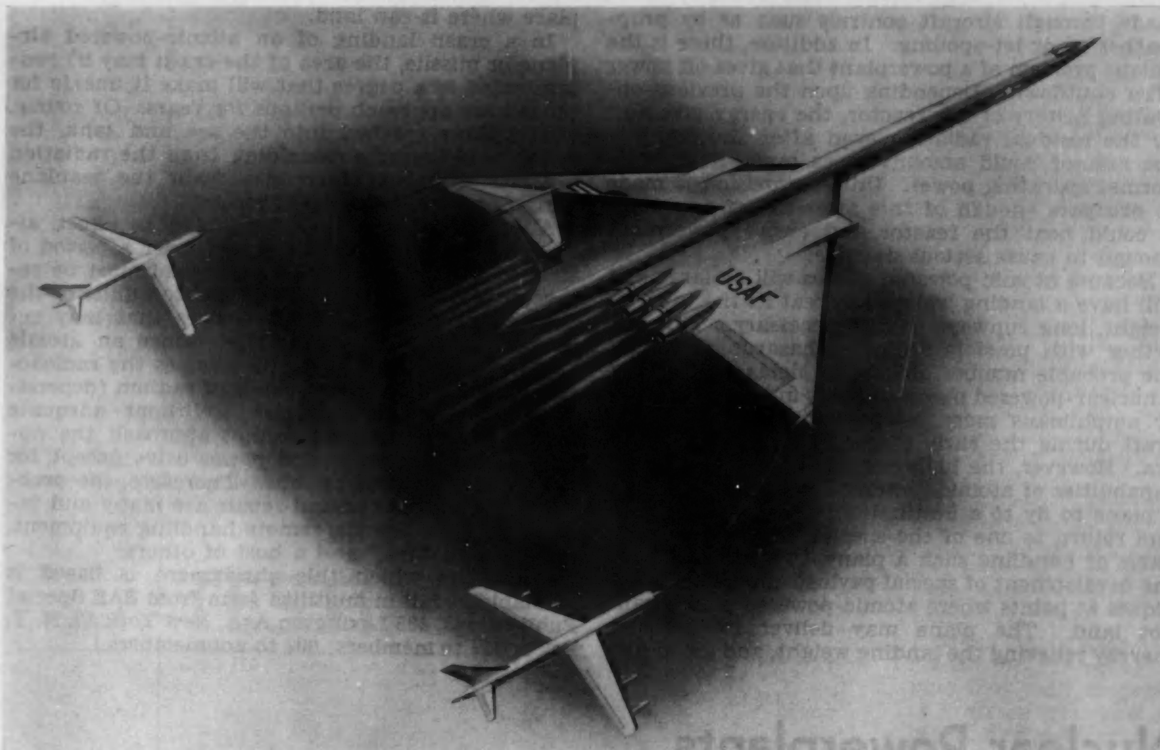
SEAPLANE has advantage of sinking its hazards in case of a crash at landing or take-off. Also it obviates need for special heavy-duty runways.



TO COMPENSATE FOR DRAG added by long nose, nuclear-powered aircraft might assume canard configuration. This is a canard suggested by Northrop some years ago. Before canards are feasible, landing and maneuvering problems must be solved.



FLYING WING CONFIGURATION might be an alternate to the long nose. Adequate separation distances between crew and radiation source could be achieved in an asymmetric flying wing by putting crew at one wing tip and radiation source at the other. Or if the wing were wide and the shielding sufficient, crew and payload could inhabit the two tip pods in a symmetric wing with powerplant at the center. Crews housed in wing tips could not, however, withstand turns about the other wing tip so well as they do on the centerline of the plane.



MOST LOGICAL CONFIGURATION appears to be delta with high length-to-span ratio. The long nose positions the crew away from the radiation hazard, yet on the plane's centerline. Sweptback wings extend the distance between crew and powerplant and help balance the nose.

This configuration might be applied to a tow plane built to circle the globe drawing commercial airliners. Transports would carry only enough fuel for take-off, landing, and limited cruising. As tow plane neared destination of a transport, the transport would cast off and proceed on its own power to the airport. Meantime its place on the tow might be taken by another plane already waiting aloft for a ride to another point.

SEPARABLE POWERPLANT (sketched here for a configuration which is not the most efficient) might facilitate maintenance. Airframe could be cared for without danger from radiation emanating from reactor. Easily accessible powerplant could be worked on under special precautions, away from the airframe.

made through aircraft controls such as by prop-feathering or jet-spoiling. In addition, there is the unique problem of a powerplant that gives off power after shutdown. Depending upon the previous operating history of the reactor, the energy given off by the residual radiation even after shutdown of the reactor could amount to as much as 10% of normal operating power. Unless provision is made to dissipate enough of this after-shutdown power, it could heat the reactor and entire powerplant enough to cause serious damage.

Because atomic-powered planes will be large and will have a landing weight as great as the take-off weight, long runways will be necessary. This, together with possible radiation hazards, will limit the probable number of landing fields available to a nuclear-powered plane and may make flying boats or amphibians more interesting than land-based craft during the early stages of the atomic plane era. However, the high endurance and long range capabilities of atomic-powered aircraft enable such a plane to fly to a destination, deliver its payload, and return to one of the special landing fields capable of handling such a plane. This may lead to the development of special payload-unloading techniques at points where atomic-powered planes cannot land. The plane may deliver its payload, thereby relieving the landing weight, and go on to a place where it can land.

In a crash landing of an atomic-powered airplane or missile, the area of the crash may be contaminated to a degree that will make it unsafe for humans to approach perhaps for years. Of course, if the plane crashed into the sea and sank, the water would serve as shielding from the radiation —a consideration which may favor the seaplane design for nuclear-powered aircraft.

Although nuclear powerplants are, in effect, almost unlimited sources of energy, over a period of time they do "poison" themselves and must be rejuvenated. In addition, the propulsion units of the powerplant are mechanical devices that may require maintenance and service. Once an atomic reactor has been in service it becomes the radioactive equivalent of many pounds of radium (depending upon its past history). Without adequate shielding, ground crews cannot approach the nuclear propulsion units and power drive except for very limited periods of time. Therefore, the problems of maintenance and repair are many and include portable shields, remote handling equipment, radiation "coffins," and a host of others.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Nuclear Powerplants . . .

. . . can compete with diesel powerplants in large ships. The Navy intends to use nuclear power to increase mobility and stayability.

Based on talk by **Rear-Adm. A. G. Mumma,** USN, Chief of the Bureau of Ships

IN ships that must stay at sea for long periods without refueling, nuclear power is not only desirable but necessary. The U. S. Navy has already proved the feasibility of nuclear-powered submarines. Despite the immense weight and volume required for radiation shielding, a nuclear power system can compete successfully with the average diesel-electric battery system.

The five transformations of energy in the diesel-powered submarine require a great deal of weight and space. Simply, these transformations are:

(1) chemical to rotative energy in the diesel engine,
(2) rotative to electric energy in the generator,
(3) electric to chemical energy in the battery, and reverse on discharge,
(4) electric to rotative in the motor,
(5) rotative to kinetic in the propeller.

Each of these transforms power in a power-rated machine. Hence, the extra weight and space of a nuclear powerplant is reasonably competitive.

In a surface ship, however, there are only three transformations of power:

(1) from chemical energy to heat in the boiler,
(2) from heat to rotative power in the turbine and gears,
(3) from rotative power to kinetic thrust in the propeller.

In direct-connected diesel engines, of course, these transformations are cut down from three to two, but the weight is still comparable. So, nuclear power will have greater difficulty invading surface ships of the Navy because the weight of the currently developed nuclear powerplants is greater than the weight of a conventional plant plus its fuel.

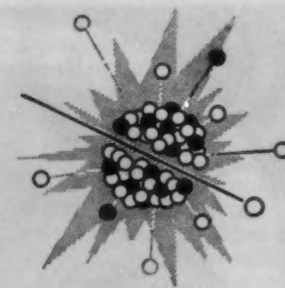
There are other advantages, however, of using nuclear power in surface ships: Elimination of smoke stacks and uptake and intakes provides space that can be used to carry more armament and cargo. And, of course, the ability to stay at sea for long periods without refueling is equally attractive to surface ships as undersea craft.

Consequently the Navy is rushing to develop nuclear power for its major surface vessels such as aircraft carriers and guided missile cruisers.

On the other hand, except in the submarine, nuclear power is not likely to replace diesel power for many smaller applications. Various types of diesel engines, free piston gasifiers, and gas turbines will continue to fill their niche in the size, weight, and space categories they always have. As long as cheap fossil or other chemical fuels are available there will always be a demand for light, high-powered, economical, chemical engines.

(Based on paper "Effect of Nuclear Power on the Diesel Engine.")

using RADIOACTIVITY in the CONTROL and TESTING of MATERIALS



RADIOACTIVITY techniques are being used in foundry operations to check stock and metal levels in cupolas and distribution of element additives.

In steel operations, these techniques are being used to check assimilation of ore concentrate fines and thickness of rolled sheet steel.

Other applications include measurement of pipe and wall thickness in pressure lines and engines, and inspection of castings and welds for internal faults.

H. A. Tuttle and G. E. Noakes, Ford Motor Co.

Based on paper "The Applications of Radioactivity for the Control and Testing of Automotive Materials."

FORD uses nuclear energy in the form of radioactivity for the control and testing of materials. Typical radioactivity applications include:

1. Radiography
2. Nondestructive testing
3. Gaging and control
4. Tracer techniques

Here's a short description of each application with specific examples to show how they're used.

Radiography

The most common use of radioactive materials, to date, has been radiographic inspection. Gamma ray emitters such as cobalt 60, selenium 75, cesium 137, and iridium 192 are most generally used in this application. They provide energies comparable to X-ray generators, and are low in cost, versatile in application, and highly portable.

The gamma ray source, generally in the form of a small metal pellet or capsule, is suspended near or inside the suspect part. A photographic film is placed on the opposite side of the part. Some of the gamma rays are absorbed by the part but enough get through to darken or expose the film. Inclusions or cracks in the material cause darker areas on the film. Fig. 1 shows a radiograph of a steel casting taken with a 1-curie cobalt 60 source. The shrinkage defects which would cause failure in service are clearly apparent.

Example 1—Weld Inspection

A new three-story office building was built using a prepoured concrete floor type construction. The floors were raised and held in position by shear plates welded to the roof support beams. Construction was done in the middle of winter and spot checks were required to insure satisfactory welds, since outward appearances could not be relied upon for absolute certification. A 0.7 curie cobalt 60

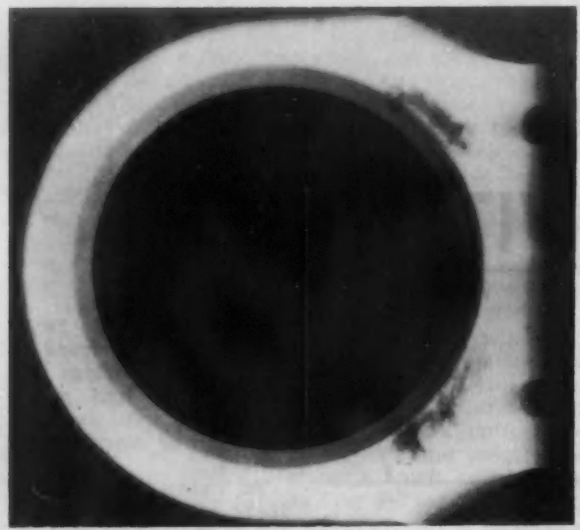


Fig. 1—Shrinkage defects (dark areas at upper and lower right) in a steel casting as revealed by radiographic inspection.

Fig. 2—Penetron inspection of a high-pressure steam line located this badly eroded pipe section.

source was used to radiograph a series of welds on location. The results certified the work with a minimum of time and expense.

Example 2—Casting Inspection

Stabilizer castings in the tail wing section of a company-owned Convair require structural certification after every 200 hr of flying time. The stabilizers are encased in the tail section and cannot be visually inspected. Therefore, gamma radiographic inspection is made on location.

Nondestructive Testing

The term nondestructive testing, as used here, includes all those applications where a measurement is made on a process or part without interfering with the operation or destroying the part—except radiography (which was discussed above). The term implies batch type testing or individual unit testing rather than continuous gaging.

Example 1—Wall Thickness Measurement

When it is necessary to measure the wall thickness of pipes, tanks, or tubes with only one side accessible, a commercial instrument of the Penetron type is used. For flat or nearly flat surfaces, the thickness is related to the amount of back scatter of the gamma rays from a radium source. For pipes less than 6 in. in diameter, the absorbance along a chord is measured. Use of the gage has made it possible to determine the extent of corrosion in high-pressure steam lines, gas mains, and acid tanks without shutting down the operation.

On one occasion a 4-in. high-pressure steam line in a powerhouse ruptured. The question arose as to whether or not the entire boiler system should be shut down for repairs. By an inspection of the lines with the Penetron the hazardous portions were replaced and the boiler placed back in operation without a costly and time-consuming major repair program. Fig. 2 shows a section of pipe located with the Penetron in which the bottom portion had eroded to a dangerous degree.

Example 2—Oil Hole Wall Measurement

In the machining of the V8 engine block using automation equipment it was found that one specific oil hole feeding a main bearing was drifting. In some blocks the hole had actually broken through the outer surface. It was immediately apparent that inspection of the blocks was required to ensure that sufficient wall thickness was present. Since no mechanical gage could be used in this application a radioisotope gage was devised.

A probe was tipped with a quantity of radioactive ruthenium and inserted into the oil hole. The intensity of beta radiation received by a Geiger counter held against the outer surface of the block determined the thickness of the metal remaining. The energy of the source was such that the beta radiation was detected only if the wall thickness was less than 0.080 in.

In this manner, several hundred engine blocks were quickly inspected. The information made it possible to segregate satisfactory blocks, and to locate the cause of the defect. It was determined that the difficulty was caused by a core shift and not a drill drift in that particular group of engine block castings.

Gaging and Control

Perhaps the most useful application of radioactivity in industry today from an economic standpoint is that of in-process gaging and control. A variety of gages for continuous noncontacting meas-

urement of mass per unit area can be constructed. Gages of this type consist of a beta or gamma source, and a detector.

The amount of absorption that the beta or gamma rays undergo when passing through the material to be measured is a function of the thickness. The relation between the intensity and the thickness can be determined experimentally or theoretically and may be represented by a calibration curve or directly on a meter scale or recorder. The detector may be a scintillation counter, a Geiger tube, or an ionization chamber, depending on the application requirements. The continuous signal may be used to actuate circuits or relays which control the process.

Example 1—Stock Height Gage

A better method was needed for determining the height of stock in the stack of closed top cupolas and water-cooled cupolas. Raw materials including metal scrap, limestone, and coke are introduced into the cupola in the melting of iron. If this stock level becomes too high or too low the operation of the cupola is impaired.

Conventional gages are of the pneumatic type in which probes are inserted into the stack at a predetermined level. If they meet an obstruction such as stock they immediately retract, indicating a full stack. In operation they are easily bent, become jammed, or misgage by entering a void in the stock.

A gage was designed which used the absorption of gamma rays as an indicator of the presence or absence of stock at a level selected for optimum operating conditions. The gage proved reliable and was coupled to the charging mechanism to permit charging control.

Example 2—Steel Thickness Gage

Measuring the thickness of sheet steel during rolling has long been a problem to the steel industry. Either the cost is too high or the gages are inaccurate. Now, a radioisotope gage has been designed which eliminates both of these disadvantages.

The gage consists of a high intensity, high energy beta source located on one side of the sheet of steel with a radiation detector located on the opposite side. The intensity of the radiation is measured and can be related to the thickness. The signal from the ionization chamber detector is fed to a balancing or bridge circuit. The error signal, or degree of unbalance, is a measure of the error in thickness of the steel and this signal is relayed to the roll screwdown motors. The rolls open or close automatically to compensate for any off-specification thickness. Tolerances of ± 0.001 in. in 0.036 in. sheet steel can be maintained whereas previous gages produced variations up to ± 0.004 in.

Tracer Techniques

The use of tracers or "tagged" atoms is becoming increasingly important in obtaining knowledge of many materials and industrial processes. The materials in question are made radioactive and their basic behavior studied. Typical applications include: wear measurements; electroplating, painting, and cleaning investigations.

A radioisotope of a particular element can be introduced at some stage of a process in a pilot operation and then followed and located with appropriate equipment. The tagged atoms give off an identifying radiation allowing them to be distinguished from their neighbors. The number present can be determined from the intensity of the radiation, and the location of a decaying atom can be found by autoradiography. (An autoradiograph is a photograph obtained when a film or plate is placed in contact with a surface containing a radioactive material and is taken by the radioactive atoms themselves as they decay, giving off particles and rays affecting the emulsion.)

Example 1—Location of Boron in Steel

A novel tracer technique has been developed to determine the location and distribution of boron atoms in steel. The method makes use of a nuclear reaction in which a slow neutron colliding with the nucleus of a boron atom is captured by the boron nucleus with subsequent emission of an alpha particle. The alpha emission is recorded on a special photographic emulsion. The entire process must be accomplished in a reactor because of the very short half-life of the radioactive boron.

In practice this is accomplished by placing a photographic film in contact with a flat piece of the metal to be tested. The metal and film are then placed inside a lead container and introduced into the thermal column of a research type slow neutron reactor. The container, while impervious to the intense gamma rays in the interior of the reactor, readily transmits neutrons which induce the radioactivity producing reactions in the boron atoms.

In preliminary experiments undertaken in the laboratory, the objective has been to explore the usefulness of this method as a means of obtaining analytical information on the amount of boron present in the steel. In addition, information as to whether the boron remains in solution homogeneously distributed throughout the crystal lattice of the steel, or whether there is a tendency to segregate at the grain boundaries, is obtained.

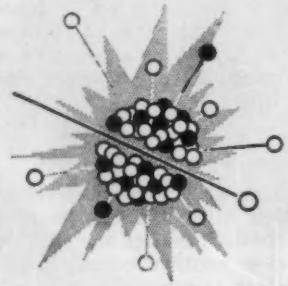
Example 2—Locating Obstructions

One company foundry has a system of pneumatic tubes approximately ¾ mile in length through which metal samples are dispatched to the laboratory for analysis, and the analyses returned. These tubes pass up and through the ceiling structure. At times obstructions develop in the tube, requiring long periods to locate and repair, owing to the inaccessibility of the tubes.

To locate these obstructions more rapidly, a 3 millicurie capsule of cobalt 60 is placed in a carrier and shot through the tube. The tube is then traced by a man carrying a survey meter. The position of the obstructed carrier is quickly pin-pointed and repairs can be carried out. To locate an obstruction by this method requires less than 10 min.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

NUCLEAR TERMINOLOGY



Some words and definitions of terms used in the nuclear engineering articles appearing in this issue of SAE Journal.

compiled by **F. L. Schwartz and H. A. Ohlgren**
University of Michigan

absorber
A material which has a high affinity for neutrons but does not fission as a result.

albedo
A unit used to measure ratios of negative to positive neutron currents, and is the ratio of the number of neutrons reflected back to the number of neutrons entering a reflector material.

alpha particle
A radioactive particle consisting of helium nucleus with positive charge made up of two protons and two neutrons.

atom
The smallest part of an element which retains its chemical and physical properties.

atomic mass unit (AMU)
A method of relating atomic mass to oxygen.

$$1 \text{ AMU} = 931.8 \text{ mev}$$
$$= 1.657 \times 10^{-24} \text{ gm.}$$

atomic mass
Relative weight of atoms when oxygen is 16.000. For practical purposes the mass equals the total neutrons and protons in the nucleus.

atomic number
The number of protons or positive charges in a given nucleus.

barn
A method of expressing probability of nuclear interaction. Practically can be considered as "target" area where one barn $= 10^{-24}$ cm^2.

beta particle
A positive or negative electron emitted from radioactive species.

breeder reactor
A device in which a controlled chain reaction takes place so that the production of fissionable atoms is greater than the number consumed.

burnup
The percentage of fissioning fuel used in a controlled chain reaction. Includes the amounts that are destroyed or converted to other materials by neutron capture.

a chain reaction
A nuclear reaction occurring so that sufficient numbers of neutrons are conserved to prompt fission in other atoms for sustained periods of time.

coolant
A liquid or gas, used for extracting thermal energy (heat) from a nuclear reactor.

critical condition
The zero power level of a reactor which sustains a controlled chain reaction.

electron
A negative charged particle which weighs 9.107×10^{-28} gm.

ev
An amount of energy required to transfer an electron through one volt of potential difference.

$$= 15.2 \times 10^{-23} \text{ Btu}$$

enrichment
Normally refers to increasing the properties of fissionable atoms to non-fissionable atoms.

fertile materials
Normally considered to be materials which on neutron capture result in eventual production of fissionable atoms.

fissile materials
Materials capable of fission with the energy ranges of neutrons present.

fission
The nuclear process by which a heavy element on reaction capture splits up into two or more fragments.

fission products
The light elements, radioactive and nonradioactive, resulting from fission.

flux
In nuclear interaction is considered the product of the number of particles per unit volume and their mean velocity.

gamma rays
A short wave electromagnetic radiation similar to X-rays but much more intense. Energies range from 10 kev to 10 mev.

half-life
The length of time for radioactivity to reduce to one-half value.

ionization
A method by which an atom or molecule acquires an electric charge.

isotope
Varieties of elements which have common chemical properties but whose atomic weights are different.

kev
One thousand electron volts.

mev
One million electron volts.

moderator
A material of low atomic mass which is used to slow down neutrons without capturing them.

multiplication constant
The ratio of neutrons of one generation to the neutrons of a preceding generation.

neutron
A particle with no charge and whose atomic mass number is 1. Symbol $-{}_0n^1$.

neutron producer
A reactor which produces neutrons for isotope production.

photon
A quantum of energy known as the smallest amount of energy travelling at the speed of light.

poison
A material in nuclear reactors which absorbs neutrons for no useful purpose.

positron
A particle which has the same weight and charge as an electron but is electrically positive rather than negative.

power density in reactors
The power produced per unit volume of nuclear fuel.

proton
A particle whose atomic mass is 1.0 with positive electric charge.

radiation damages
Undesirable changes in structural, chemical, and physical properties resulting from nuclear radiation.

radioactivity
The process by which an unstable atom releases energy in the form of alpha particles, beta particles, and/or gamma rays.

reactivity "k"
Reactivity "k" is equal to the ratio of

$$\frac{k(ex)}{k(eff)} = \frac{k(eff) - 1}{k(eff)}$$

The ratio establishes the control of the power level of a nuclear reactor where:

$k(ex)$ = excess neutron multiplication factor
$k(eff)$ = effective neutron multiplication factor.

When reactivity is negative, a power reactor becomes subcritical; when it is zero, the power reactor is under control; and when it is positive the reactor becomes supercritical.

reflector
A material incorporated in and surrounding the reactor fuel which reflects neutrons at energies so that they are useful in fission.

recovery of reactor fuels
Processes for recovery of reusable reactor fissile and fertile materials with adequate separation of fission products and spent structural materials.

roentgen
A standard unit of radiation close. The quantity of X-rays or gamma rays which produce one electrostatic unit of electricity per cubic centimeter of air at standard pressure and temperature.

shield
A radiation absorbing structural material which reduces radioactivity and nuclear particles to levels to permit human operation within reasonable distance from radiation source.

temperature coefficient
The change of reactivity divided by a cnange in temperature.

$$\alpha_1 = \frac{\partial\delta}{\partial T} = \frac{(\delta - \delta_0)}{(T - T_0)}$$

When the coefficient is negative, increase in temperature decreases reactivity; when the coefficient is positive, increase in temperature *increases* reactivity.

1956

SAE Journal Index

soon to be available — at No Charge

AN INDEX of all technical articles published in the 1956 issues of the SAE **Journal** will be ready about March 1.

It's **FREE** for the asking. To get your copy, write to: Editor, **SAE Journal**, 485 Lexington Ave., New York City 17.

SAE Journal sooner or later prints an abridgment of every paper presented at SAE National and Section Meetings. So, every paper is mentioned at some time in the INDEX.

Every paper is indexed by:

1. Original title.
2. Journal headline.
3. Authors' names.
4. Subject headings.

When the **Journal** article contains discussion, the names of the discussers are also listed.

The 1956 INDEX covers all material published in the **Journal** during 1956, based on the following:

1. Papers presented at National Meetings.

2. Papers presented at Section Meetings, received at SAE Headquarters.

3. Round table and production panel reports received at SAE Headquarters.

SAE LOOKS OVERSEAS

by PAUL A. MILLER, *Ford Motor Co.*

Mr. Miller toured automation plants in England, Ireland, France, Germany, and Switzerland last fall, and wrote this report at the invitation of the SAE Overseas Information Committee.

EUROPEAN COMEBACK

Since 1945 German industries have recovered remarkably well. During a two to three year rebuilding period, teams of German engineers were sent all over the world to observe the latest in manufacturing processes and techniques. In many cases they improved processes observed in the United States.

MASS PRODUCTION IN EUROPE

Several companies in Europe are producing in volumes almost equal to companies in the United States. In general, methods, processes, and technical advances in the United States are superior to those in Europe; however, in many areas of research and development and in unusual methods and processes, Europe surpasses the United States.

For example, there are plants in England that produce 7000 automotive starters and generators, 8000 voltage regulators and 50,000 lamp assemblies per day. In Germany, there are plants that produce 5000 automotive starters and generators and 30,000 lamp assemblies per day.

INTEGRATED DEPARTMENTS

Many European companies are integrating some departments to reduce materials handling. In one factory the stamping presses; polishing and buffing; copper, nickel, chrome plating; painting, assembly, and shipping departments were a straight line operation.

This feature is an activity of the SAE OVERSEAS INFORMATION COMMITTEE, C.G.A. Rosen, chairman

SAE LOOKS OVERSEAS

BUMPER PLATING

Automotive parts are produced that stand the equivalent of 250 hr salt spray test. Some bumpers are plated using 0.0003 in. copper, 0.0015 in. nickel and 0.00001 in. chrome. This is twice the normal thickness of nickel used in plating bumpers. The bumper is guaranteed to resist corrosion for three years.

SUBSTITUTES USED

In many companies, brass is used as a raw material instead of steel for headlamps, tail lamps and dome lamps. The surface finish is excellent. Although the initial cost of brass is higher than steel, the net results offer better quality and cost reductions in finishing operations during chrome plating operation.

CLOSER LIAISON

After seeing the vast gains made since 1945 and observing the tremendous research and development programs now in effect and planned in the future, I believe many mutual advantages can be gained with a closer liaison between the U. S. manufacturers and those in Europe. We must admire their courage, their optimism and determination to turn their backs on the past and look to the future.

Molded commutators are used extensively in automotive generators and starters. Mica is completely eliminated and copper requirements are reduced to half that of a standard steel shell commutator. They are being produced by impact extrusion.

MOLDED COMMUTATORS

Six or seven coil feed punch presses are being operated by one man. A safety mechanism safeguards against misfeeds, mishits, buckled material, or folding of material. On presses fitted with electric pneumatic clutches, at 100 strokes per min., the ram of a 100 ton press will brake to a standstill in 3.4 in.

Punch presses are located next to stack assembly operations. Laminations are fed, as punched, directly to the assembly operation. The assembly operator also operates the punch press. Armature lamination dies are operating at 190 strokes per min., producing three pieces at a time. These lamination dies were said to blank 20,000,000 pieces per grind of 0.10 in.

1957 SAE Annual Meeting Story

continued from page 19

THE 1957 SAE Annual Meeting taxed meeting-room capacities of TWO hotels, . . . only four years after it first became necessary to spread this once-a-year Detroit event beyond the confines of the Sheraton-Cadillac. This year technical sessions and committee meetings bulged walls at *both* the Statler and the Sheraton-Cadillac.

S.R.O. signs were common at the technical sessions. At some, such as the one on Automotive Fuel Injection, the foyer, too, was full of people who couldn't get in.

The meeting ran officially from Monday, January 14 through Friday, January 18. But many preliminary - to - committee - meeting discussions began informally on Sunday the 13th . . . and a few post-mortems were still going on in the early morning hours of the 19th. From start to finish, this 1957 gathering was bigger but faster . . . deeper but more exciting than any of its predecessors.

Almost the last traces have gone from formal technical sessions of the easy-going person-to-person discussion which characterized such sessions in the 20's and before. Today the tempo of an Annual Meeting has in it something of a roaring jet, something of a tempestuous symphony, something of a powerful dynamo. Yet, in the Activity committees, and in the technical committee meetings is growing up informal interchange of technical information which resembles more than a little the small-session atmosphere of the old small-Society days. In a variety of ways, SAE members are finding ways to preserve the best of traditional values while grasping fully the potentials of new requirements.

The exchange of technical information was going on almost continuously throughout the week. No one reporting group could hope

A LIFE MEMBERSHIP in the Society went to SAE Past-President William Littlewood (right) on the occasion of his completing his second year on SAE Council as a past-president. Presentation was made by 1956 President George A. Delaney at the Annual Business Session of the Society on Tuesday, January 15.

to be everywhere at once, learn everything that was talked about . . . but the article titled, "The New Automotive Engineer" (p. 17) distills some of the ideas and some of the implications from a wide range of technical sessions, committee meetings, and informal gatherings about the meeting.

Most of the Society's important administrative committees met during the week, as did many of its important technical committee groups. At the Annual Business Session of the Society on Tuesday evening, SAE Past President William Littlewood was awarded a Life Membership in the Society . . . and 1957 President W. Paul Eddy spoke briefly following the report of the tellers which announced his election to office. He was introduced to the Business Session audience by 1956 President George A. Delaney.

Over 1500 people—most of them SAE members—worked for more than a year to put this 1957 Annual Meeting on. This is about one-fourth of the nearly 6000 members and guests that attended the meeting.

More than 400 SAE members participated in more than 40 meetings of the SAE Meetings Committee, the 12 Activity Committees, and the Display Committee held during 1956 to develop the technical, dinner, and luncheon programs and the engineering display.

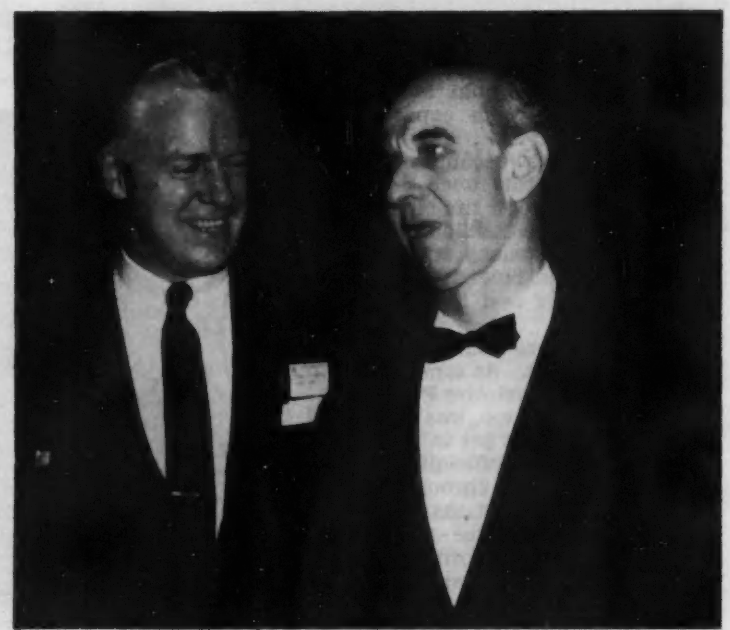
As a result:

- 170 program participants—speakers, chairmen, and secretaries—were put to work preparing their papers and presentations.
- Representatives of 119 companies swung into action preparing their exhibits for the engineering display.
- Over 100 SAE committees started plans for committee meetings to be held during the meeting.

And finally, to operate the meeting, the Detroit Section Reception Committee, just about the entire SAE staff, hundreds of Detroit's hotel and Convention Bureau personnel, projectionists, public address experts, and students aids got into the act. . . .

The 1957 Annual Meeting proved in every way to be an outstanding example of the truth of George Delaney's often-proved statement: "Cooperative activity is the vital element in SAE's success."

Annual Dinner Program A Highlight of Meeting



C. C. DYBVIG, DETROIT SECTION CHAIRMAN (left), welcomed the diners to Detroit at the start of the speaking program. Clifton Beckwith, humorist and satirist, was the principal speaker.

AT THE DINNER, 1957 SAE President W. Paul Eddy told of progress in planning for the Society's future in his inaugural talk—which was printed in full in the Roster Issue of SAE Journal (which went in the mails on January 22.) . . . 1956 SAE President George A. Delaney presided over the dinner's speaking program.

UNIVERSITY OF DETROIT CHORAL Group entertained in the intermission between the dinner and the speaking program which followed.

H. E. Chesebrough
Chairman,
Dinner Program Committee

SAE PAST-PRESIDENTS, CAUGHT IN ACTIVE DISCUSSION, typify the spirit and liveliness of the 1957 Annual Meeting, the largest and fastest-moving event in the Society's history.

In the discussion photographed above are (left to right) **Ralph R. Teeter** (president in 1936); **James M. Crawford** (1945); **J. G. Vincent** (1920); and **D. G. Roos** (1934).

Among the 17 past-presidents in attendance at the Annual Dinner this year were the nine whose photographs appear on this page, and also:

(1952) **D. P. Barnard**
(1941) **A. T. Colwell,**
(1947) **C. E. Frudden,**
(1942) **A. W. Herrington,**
(1944) **W. S. James,**
(1954) **W. Littlewood,**
(1940) **Arthur Nutt,**
(1955) **C. G. A. Rosen.**

Dale Roeder (1951) **James M. Crawford** (1945)

J. C. Zeder
(1950)

Robert Cass (1953) **R. J. S. Pigott** (1948)

J. H. Hunt
(1927)

New James M. Crawford Fund . . .

. . . aims to stimulate further SAE's widely manifested cooperative action spirit. Announced at Technical Board Honors Luncheon.

PAST-PRESIDENT James M. Crawford has turned over securities to the SAE with the request that the income of approximately $685 per year be used to stimulate and further mature the Society's widely manifested cooperative spirit and methods of getting things done.

It is this spirit and method, Crawford believes, which is responsible for SAE's greatest contribution to members and to industry. It is particularly characteristic, he feels, of the Cooperative Engineering Program which has stemmed from the technical committee work arrayed under the SAE Technical Board banner.

Crawford has long felt that his experience in cooperative engineering work in SAE was of great value in a career which took him to be vice-president of engineering, General Motors Corp., before his retirement a few years ago.

But it was an experience since his retirement that brought this SAE contribution to new focus in his mind . . . and led him to express his appreciation through a gift to the Society.

Crawford's hope, as expressed to 1956 SAE President George A. Delaney (whose Council accepted the gift for the Society), is:

> "To see the cooperative method of getting things done preserved . . . and matured to even higher levels of development in SAE."

"When I retired in 1951," Crawford said at the 1957 Technical Board Honors Luncheon, "I looked forward to getting away from all the pressures and obligations to which today's automotive engineers are subjected. I wanted to get back to what I had originally started out to be . . . a creative artist.

PAST-PRESIDENT JAMES M. CRAWFORD (left) tells 1956 SAE President George A. Delaney about the line of thought which led to his contribution manifesting appreciation of SAE's assistance to individual development through its cooperative engineering program. The contribution was accepted and established as "The James M. Crawford Fund" by the 1956 SAE Council.

"So, after 44 years of divorce from art, even as a hobby, I associated myself with a group of San Diego businessmen who had organized to make this avocation a hobby. I found this association a satisfying and worthwhile way of living . . . making new friends and being able to create something through my own efforts.

"Within a year, however, I found myself a member of the Board of Directors of the Art Center in La Jolla. As its secretary besides, I began to participate again in projects where a variety of related interests were to be served. And, facing the inevitable problems involved, I found myself recalling my administrative experience in industry at General Motors and my activities in SAE. I found myself remembering how successful and effective had been the cooperative method of operation in both areas. . . . And soon, I began to find, these teachings were equally applicable to these post-retirement problems in a field totally unrelated to my past automotive environment.

"Thus, I became refreshingly aware of the part SAE had played in my own development; how effectively it had provided me an opportunity to participate in its various cooperative activities.

"With this realization, came a desire to somehow reflect tangibly SAE's contribution to my progress. To be an accurate reflection of my appreciation, I felt that any expression from me should not impose limitations which might make the use of income from a fund impractical financially for the Society in the years ahead. I felt, too, that it should not influence the course of the Society by its demands for specific projects. Rather, it should supplement activities of a cooperative nature in the technical area . . . activities such as would be sponsored by the Council irrespective of the existence of any fund.

"I finally chose the technical area in which to make a tangible

expression of my appreciation, because it was in this area that my cooperative participation in SAE activities benefited me most."

Council Accepts Fund

It was this line of thinking which resulted in contribution by Past-President Crawford to SAE of 70 shares of General Motors Management Stock, which SAE Council accepted at its September 12, 1956 meeting as "The James M. Crawford Fund."

Minutes of that Council meeting describe the specific elements involved in the acceptance:

"1. The Society accepts from Past-President James M. Crawford 70 shares of the common stock of GM Shares, Inc., to be the basis for a James M. Crawford Fund, the income from which the Society will devote to:

ENRICHMENT of satisfactions to individual members resulting from their participation in SAE technical committee work . . .

"The Council accepts also the Donor's suggestion that immediate application of the funds be to enable the SAE Technical Board to be host at a yearly luncheon designed to provide a stimulating background and a suitable occasion for presentation of the Technical Board's Certificates of Appreciation.

"The Council expresses its great gratification for this gift which will help carry on the traditions which have made our Society great; and for the spirit in which it was given, which so well typifies the spirit of the Society which Past-President Crawford did so much to promote.

"2. The Council delegates to its Executive Committee such decisions on policy in the use of the James M. Crawford Fund as may be necessary from time to time;

"The Council itself will take such action as may be necessary in the actual handling of the fund, based upon recommendations from its Executive Committee."

Technical Board Makes Awards at Annual Meeting

CERTIFICATES OF AWARD for outstanding services in technical committee work were presented to one more than the usual 30 men by the Technical Board at its annual luncheon this year.

The men who received certificates—and the committees to whose work they contributed so effectively were:

Aeronautics Committee
B. N. Ashton
W. K. Bonas
L. D. Bonham
J. C. Buckwalter
A. T. Gregory
P. H. Jones
R. C. Rethmel
P. V. Richards
W. C. Schulte
R. F. Schwarzwalder
M. A. Wachs

Electrical Equipment Committee
R. H. Bertsche
A. D. Gilchrist

Engine Committee
J. F. Greathouse

Fuels & Lubricants Technical Committee
J. C. Geniesse
F. A. Suess

Hydrodynamic Drive & Transmission Committee
F. R. McFarland

Ignition Research Committee
F. P. Seitz

Iron and Steel Technical Committee
P. R. Wray
V. A. Crosby
F. C. Young
M. L. Frey

Lighting Committee
Don Blanchard
A. W. Devine

Non-Ferrous Metals Committee
W. E. Day, Jr.

Screw Threads Committee
R. F. Holmes

Surface Finish Committee
A. F. Underwood

Transportation & Maintenance Technical Committee
E. P. Gohn
M. E. Nuttila

Tube, Pipe, Hose & Lubrication Fittings Committee
L. H. Schmohl

THE 31ST "SURPRISE" certificate was awarded to SAE Past-President James M. Crawford, in whose presidential year the Technical Board came into being . . .

LUNCHEON TALKS . . .

. . . featured top-level speakers from Air Transport, Production, and

At the Production Activity Luncheon

TODAY'S composite American is 30.2 years old . . . and represents both a challenge and an opportunity to engineers in automotive manufacturing areas, Louis C. Goad, GMC's executive vice-president told his luncheon audience on Wednesday, January 16.

He went on to describe this composite American and the challenge he brings in these words:

"As many are older than he as are younger than he. He is located at the center of population in Illinois, facing westward with the rising sun warming his back.

"His age places him at the heart of the nation's labor force and he is adding to and sustaining the highest standard of living in the world with only 40 hours a week of work.

"He is living well, working quite hard, and looking to easier days ahead. On his right arm he cheerfully supports the aged who add wisdom to our way of life. On his left arm, he bears the very young who are the bone of all our tomorrows. He moves along his path of life quite carefree and content. Only once in a while does he worry about a bear which moves along the path with him and from the bushes sends messages of peace.

"He is at once a challenge and an opportunity to manufacturing engineers. By applying the knowledge and skill at their command, these engineers can continue to make life in these United States abundant, find ways to replenish the earth, and to remain masters of its materials and energies which, even now, are waiting to be mastered for the benefit of all."

Pontiac's General Manager S. E. Knudsen (left) was toastmaster at the luncheon where GMC's executive vice-president L. C. Goad (center) was the speaker. Chairman at the luncheon was SAE Vice-President D. S. Kimball, Jr. (left), vice-president and general manager, Bendix-Westinghouse Automotive Air Brake Co., whose Activity sponsored the session.

At the Passenger Car Activity Luncheon

Chrysler Corp.'s Vice-President James C. Zeder (center), as toastmaster introduced principal speaker Dr. L. R. Hafstad (right), who stressed the need for both scientists and engineers. L. H. Nagler of American Motors (left) is SAE vice-president representing the Passenger Car Activity, which sponsored the session.

THE automotive industry needs the scientist as well as the engineer, Dr. L. R. Hafstad emphasized in a luncheon address Monday, January 14.

Speaking as a physicist come relatively recently into the automotive industry—Hafstad was a pioneer researcher on nuclear energy who became director of General Motors' Staff 18 months ago—he reminded the executives of the automotive industry that there are implications for them in developments in almost any field of science. Let your research lab-

Passenger Car engineering areas. These pages report highlights.

oratory keep you abreast of developments outside the usual straits of automotive engineering and give your research scientists the freedom to do some basic research, he urged.

Referring to the piston engine and tetraethyl lead, he reminded his audience that it wasn't until Midgeley, an automotive engineer, went prospecting in the field of metallo-chemistry that he found the means to alleviate combustion difficulties. Chemistry, statistics, and systems engineering have much to contribute to the industry today, Hafstad feels.

Basic research definitely is a proper function of industry, he maintains, even though in our society it is not a primary responsibility. Industry is certainly justified in supporting basic research to the extent that research enables industry to maximize its contribution to society—that is, to produce more and better goods at lower cost.

Hafstad's parting admonition: Good basic research may appear useless at the time it's performed yet furnish ideas that prove invaluable later. On the other hand, just because your scientific activity is useless, don't assume that it's good basic research.

At the Air Transport Activity Luncheon

"IN spite of delays and cancellations, under adverse weather conditions, most of the time a vast majority of our aircraft get where they are going on time and their passengers enjoy comfort and luxury," said Edward P. Curtis, special assistant to President Eisenhower for aviation facilities planning when he talked to the luncheon sponsored by the SAE Air Transport Activity on Friday, January 18.

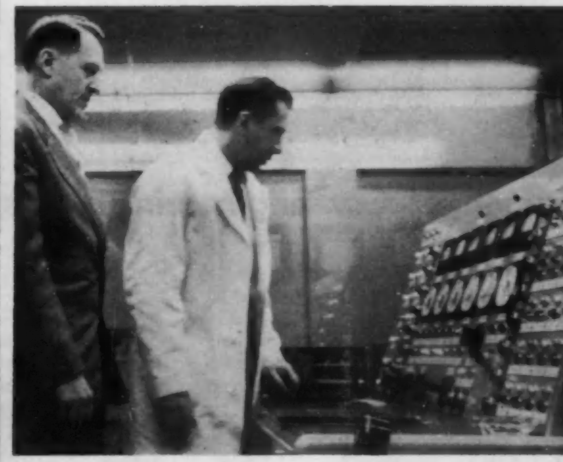
"In spite of occasional tragic accidents," he continued, "the overall picture of air safety is a good one and the record compares favorably with other forms of transportation."

Based on studies currently well on their way, he looked ahead to 1975 in the air transport traffic and equipment area. Among his comments on possibilities by 1975 were the following:

- By 1975, about 90% of the passenger trunk-line fleet will be turbine-powered . . . of which 40% will be large jet transports with a seating capacity of 90 or more.
- In New York, by 1975, the airlines alone will probably account for 650,000 take-offs and landings per year. (In 1956, they accounted for 450,000.)
- By 1975, the numbers of aircraft and aircraft movements in general aviation may increase to four times the 1956 figures.
- Turboprop air transports of the 60's and 70's will cruise at about 350 knots between 10,000 and 25,000 ft.
- Before 1975, it will be technically possible to design and build supersonic transports, but present indications are that their operating costs will be substantially higher than the present subsonic types.
- If before 1975, a supersonic transport should appear, it will probably fly at speeds of Mach 2—2.5 at altitudes of about 55,000 ft.

"As we are able to move increased airborne traffic more and more expeditiously," he concluded, "our airports will become increasing limiting factors in the system . . . unless they are improved and extended both in their capacity to accept more aircraft on the runways and to improve the facilities for maintenance and the handling of cargo and passengers on the ground."

E. P. Curtis (left), Special Assistant to Eisenhower for Aviation Facilities, reported very specifically on aviation facilities planning at the luncheon sponsored by the SAE Air Transport Activity. Toastmaster was W. W. Parrish (right), American Aviation Publications, Inc.



C. R. Lewis, chairman of SAE's Nuclear Energy Advisory Committee, and Prof. Comberg at controls of the reactor.

U of M Shows Its

THE University of Michigan entertained two groups of SAE visitors during Annual Meeting. One group was comprised of members of the SAE Nuclear Energy Advisory Committee who spent a half day exchanging information with the staff of the Michigan Memorial-Phoenix Project on peaceful uses of nuclear energy. The other group consisted of about 100 SAE members and guests who toured the University's North Campus aeronautical research facilities and some of the Phoenix Project "hot labs."

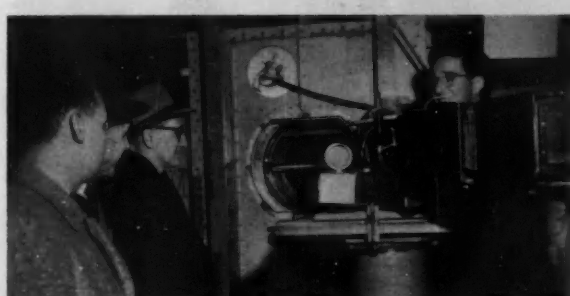
Both groups observed some of the checks being carried out to assure that the rooms in which nuclear-energy experimentation will be carried out are completely gas-tight. In case radiation is accidentally emitted outside test containers, it must not be allowed to pass out into areas where it can harm personnel. So doorways must be sealed and cinder block walls made impermeable to gases.

Prof. Wilbur C. Nelson explained that the idea for the SAE tour originated with SAE member and Michigan alumnus Robert Woods of Bell Aircraft, who died a few months ago. Nelson, who is chairman of the aeronautical engineering department, welcomed the visitors. Prof. Henry J. Gomberg, assistant director of the Phoenix Project, addressed them after luncheon at the Michigan Union.

Standing on bridge of new 1,000,000-w Ford Nuclear Reactor, members of SAE Nuclear Energy Advisory Committee look into 41,000-gal "swimming pool" in which the reactor's uranium-aluminum fuel supply will be located.

SAE tourists see how airflow through a turbine cascade is being studied by means of light interference in this Zehnder-Mach Interferometer at Aircraft Propulsion Laboratory on University's new North Campus at Ann Arbor.

Research Facilities to SAE Guests



Air speeds up to Mach 4 are attained in this 8 x 13-in. test section of Aerodynamics Lab's fixed-block tunnel.

Ozone's effect on flame characteristics is being studied with special equipment in Propulsion Laboratory.

Low-velocity, low-turbulence, gust-generator wind tunnel draws many visitors to peek into portholes of test section.

Administrative and Special

Whitney Collins, chairman of the Detroit Section Long-Range Planning Committee (standing), is shown presenting a report of his section's activities to the Sections Committee while T. R. Thorne, 1957 chairman of the committee looks on.

WHEN more than 6000 members and guests of the SAE from all over the country get together as they did at this meeting, committees are bound to benefit. And that's what happened in nearly every case. The nearly one-dozen administrative and special committees that got together were able to function really effectively because of the high percentage of members present.

At breakfast, lunch, or at other times, the administrative committees enthusiastically made plans to improve SAE operations of all kinds—develop better meetings, improve Sections operations, increase membership, and the like.

In addition, two special committees, set up in recent years to help get more material on nuclear energy and also to bring technical information from abroad into the SAE, met and discussed their problems. The Overseas group, for example, explored ways of developing "listening posts" abroad, so that material of interest to SAE members would be ferreted out and gotten into the SAE bloodstream.

Shown here is a group of pictures taken while some of these groups were "in action."

Features of the Membership Committee luncheon were a series of reports by several Section Membership Chairmen, and the introduction of the 1957 Membership Committee Chairman.

(Upper right picture) (left to right) panel members Dale Streid and G. E. Burks and 1957 Membership Committee Chairman F. B. Lary await their turn to talk.

(Lower left picture) R. S. Frank (standing), 1956 chairman, addresses the group while panel members Phil Pretz (center) and Jim Yingst look on.

Committees

1 **Members of the Overseas Committee** help Chairman C. G. A. Rosen check over his report to the committee. Standing, left to right: D. P. Barnard, Robert Burkhalter, M. A. Thorne. Seated: Jack Dyment, Dr. Rosen, W. E. Jominy.

2 **Finance Committee Chairman A. T. Colwell** (center) held a meeting of group leaders working under SAE Finance Committee sponsorship to gain increased financial recognition for the SAE Technical Board's Cooperative Engineering Program.

At the session, 1956 Technical Board Chairman Robert F. Kohr (left), sketched the growing breadth and depth of the work with which SAE technical committees are serving industry. Frank W. Fink (right) was among the group leaders who attended. He is vice-chairman for the accessory and instrument group on the West Coast.

3 **The planning for Progress Committee** met to continue its development program. Left to right: Leonard Raymond, G. A. Delaney, Chairman R. J. S. Pigott, and W. Paul Eddy.

4 **The Placement Committee** also met for lunch. Shown here is 1957 Chairman Lowell Ray conferring with 1956 Chairman Herbert Happersberg.

TECHNICAL COMMITTEES

The Ignition Research Committee poses for the camera as the group finishes its work for the day.

The Aeronautics Committee shown here hard at work.

The Body Engineering Committee takes time out for a group picture.

The Aircraft Gas Turbine, Ram-Jet & Rocket Engine Ignition Subcommittee poses before taking up their problems of the day.

The Joint Subcommittee on Human Shock & Vibration Tolerance enjoy being photographed.

The Division 4-Residual Stresses group meets to consider some of its current problems.

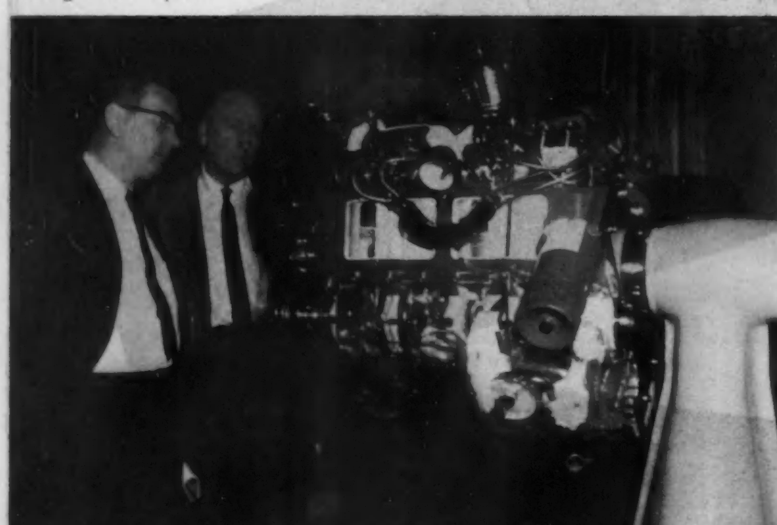
EXHIBITS

A CUTAWAY of the Chrysler Torque-Flite transmission (shown above) was described by S. D. Jeffe and B. W. Cartwright of Chrysler.

FULL-SCALE models of the scientific earth satellite now being built at the Naval Research Laboratory provoked the most continuous, if sometimes somewhat disbelieving, interest at the meeting. This satellite, which is being built under Project VANGUARD, is expected to be launched sometime during the International Geophysical Year (July 1, 1957 to Dec. 31, 1958). As shown on the next page, one model was made of metal, with the four antennas attached. The other one was transparent, to show the subminiaturized instruments the satellite will contain.

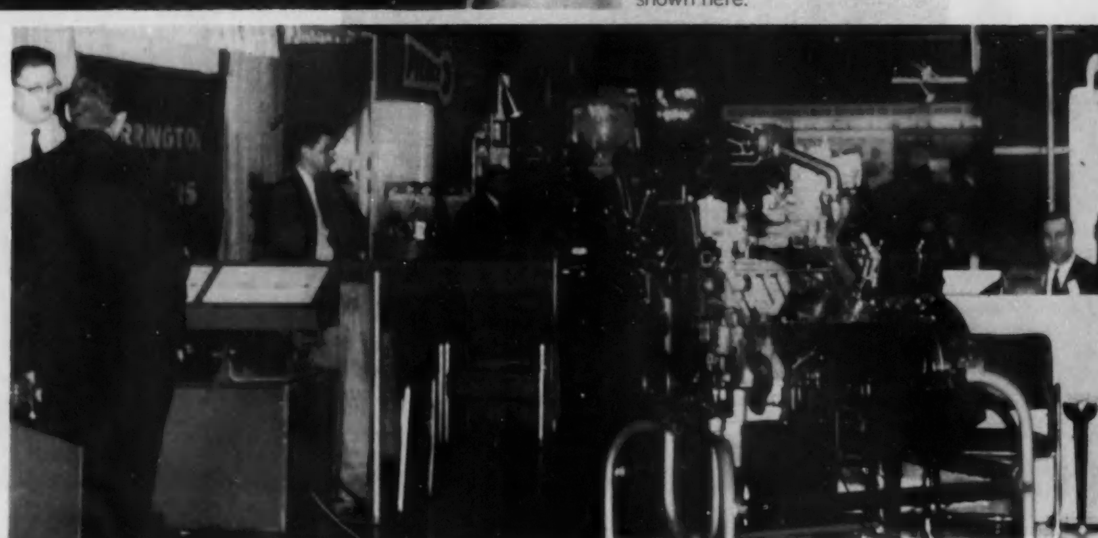
There were exhibits of some of the new accessories being described in several of the technical papers being presented, such as fuel injection and new automatic transmissions.

There were also the exhibits of the 79 companies participating in the Engineering Display. Large crowds spent many man-hours avidly studying the new products and improvements to old products shown by these companies.



A CHEVROLET engine was mounted on a stand so it revolved to display, from all angles, the GM fuel injection system installed on it. This system was described by John Dolza, E. A. Kehoe, Donald Stoltman, and Zora Arkus-Duntov of GM.

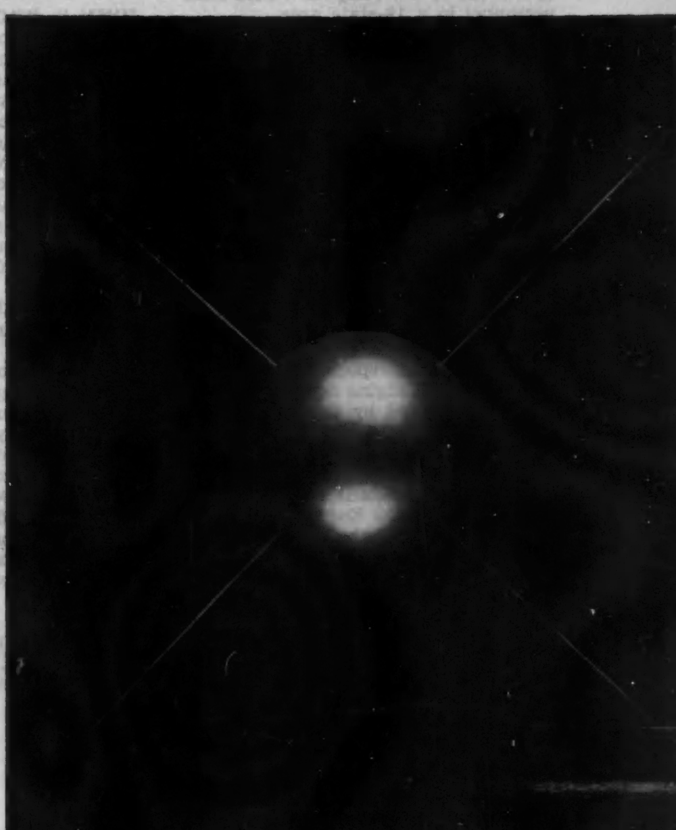
THE ENGINEERING DISPLAY took up all available space on the main floor and overflowed on to another floor. A view of one small section is shown here.



Dr. C. G. A. Rosen, (above left) was an interested viewer of the earth satellite display. As a member of the group in Peoria, Ill., that is making plans to help track the satellite as it passes overhead in their newly renovated 11-in. reflector telescope, Dr. Rosen was particularly interested in learning details of the program from John J. Lister of the U.S. Naval Research Laboratory.

The scientific earth satellite will be a tiny "moon" measuring 20 in. in diameter and weighing only 21½ lb. Instrumentation in it will weigh less than 11 lb. It is expected to include solar cell mercury batteries, ion chambers, thermistors, erosion gages, a Minitrack transmitter, meteorite collision memory devices, telemetry coding systems, and Lyman alpha storage units. Such instruments will permit scientists to carry on many new studies in the field of upper atmosphere research.

The project was undertaken at the request of the U. S. National Committee for the International Geophysical Year, the National Academy of Sciences, and the National Science Foundation. The program is a joint venture under Navy management, with the Army and Air Force assisting. The Naval Research Laboratory is actually building the satellite.



JOHN G. HOLMSTROM has been appointed to the newly created position of vice-president of engineering and research and development for all divisions of Pacific Car and Foundry Co. Formerly, he was vice-president in charge of the Kenworth Motor Truck Co. Division of the firm.

Holmstrom first went to work at Kenworth in 1923, part-time, after high school hours. Continuing with the firm while attending the University of Washington, he was a mechanic's helper and then a mechanic, later becoming a draftsman and engineer.

In 1941, he was made vice-president in charge of engineering at Kenworth. Four years later, he was named general manager. He became a vice-president of Pacific Car and Foundry Co. in 1946, and was elected to the firm's board of directors in 1949.

H. C. EVANS, who opened the Akron offices of Enjay Co., Inc. in 1955, has been designated Akron district manager.

Evans joined Enjay in 1947, and previously had worked in the chemical-products operations of Esso Standard Oil Co.

He opened Enjay's Tulsa offices in 1954 and served there until transferred to Ohio in 1955 to open the Akron offices.

J. P. HAWORTH has been named manager of the newly established Eastern Sales Division of the Enjay Co., Inc. Previously, he was assistant sales manager of Enjay's Butyl Division.

Haworth will be responsible for the operations of the company's field sales personnel in a 19-state area.

Before joining Enjay in 1955, he had been with the Esso Research and Engineering Co. for 15 years.

WESLEY E. SCHWIEDER, manager of powerplant engineering, Packard Division, Studebaker-Packard Corp., has been appointed chief engineer for research and development of tractors and engines of Minneapolis-Moline Co.

Schwieder began in the engineering field in 1939 as a junior engineer with the Engineer Research and Development Laboratories. Later he was made chief of the special equipment section, handling special construction equipment and engine development activities conducted by the Army Engineers during World War II.

Late in 1945, he joined the Kiekhaefer Corp. as a project engineer, advancing to assistant chief engineer. He returned to the Engineer Research and Development Laboratories early in 1947, becoming chief of the engine branch in 1948.

In 1953, Schwieder joined the Packard Motor Car Co., now the Studebaker-Packard Corp., and was assigned responsibility for the automotive engine program.

About SAE


Holstrom


Evans


Haworth


Schwieder


Manganiello


Weber


Keller


Carter, Sr.

JOHN S. BROCK has been named superintendent of Cremazie and Youville Shops at the Montreal Transportation Commission. Prior to this appointment, he was mechanical superintendent of the Autobus Department at the Commission.

GUY L. BLAIN will now be responsible for the preventive maintenance of autobuses, street cars, and trolley coaches for the Commission. Formerly, he was supervisor of operating garages for the Commission.

DR. LAWRENCE R. HAFSTAD, vice-president in charge of General Motors Corp.'s research staff, was voted the Proctor Prize as one of the nation's leading scientists, by the board of governors of the Scientific Research Society of America.

Presentation of the award was made at a combined meeting of the Scientific Research Society and Sigma Xi, national scientific fraternity, in connection with the annual meeting of the American Association for the Advancement of Science.

LAWRENCE LIMBACH, formerly vice-president, manufacturing, Ryan Aeronautical Co., has been named vice-president and general manager of the Government Products Division, Rheem Mfg. Co. Limbach's SAE activities include chairmanship of the San Diego Section and membership on the Executive Committee for the Aircraft Production Forum.

EUGENE J. MANGANIELLO, assistant director of the Lewis Flight Propulsion Laboratory of the National Advisory Committee for Aeronautics at Cleveland, has been awarded a scholarship by alumni of the American Management Association's management course to attend the course in New York City.

Manganiello began his service with the NACA, the Government's aeronautical research organization, in 1936 as a mechanical engineer. He was appointed assistant chief of research at the Lewis Laboratory in 1949, and has held his present position since 1952.

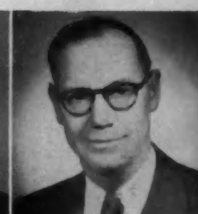
PHILIP F. WEBER, formerly factory manager at Kollsman Instrument Corp., has been appointed assistant to the company's president. He will be responsible for monitoring production, providing interdepartmental liaison, and maintaining central analysis for all instrument systems.

Weber joined the firm in 1935 as a

Members


Brock


Blain


Hafstad


Limbach


Radamaker


Green


Morrison


Chaffee

project engineer and became factory manager in 1945.

K. T. KELLER, retired chairman of the board of Chrysler Corp., will be general chairman of the 1957 Michigan Week observance which will be celebrated next May 19 to 25.

N. A. CARTER, SR., vice-president of Fruehauf Trailer Co. for the last five years, has retired. He will continue to act as a consultant for the company.

In 1905, Carter entered the service of the Illinois Central Railroad Co. as a machinist's apprentice. He started in the automobile business as a salesman in 1912. Six years later, he opened a Ford dealership in Erle, Ark., which he operated for nine years.

In 1924, Carter left the dealership to organize the Carter Mfg. Co. in Memphis. When Carter Mfg. became a part of the Fruehauf Trailer Co. in 1947, he was named manager of the Memphis plant. He has since served in the Fruehauf organization as regional manager and vice-president.

GEORGE L. RADAMAKER has been named chief engineer of the leaf spring department, Spring Division, Eaton Mfg. Co. He has been assistant chief engineer at Eaton since 1946.

Prior to joining Eaton in 1945 as a draftsman in plant engineering, he was associated with the Carnegie Illinois Steel Co. and the Borden Co.

ROBERT G. GREEN has been appointed assistant sales manager of the leaf spring department at Eaton. He had been with the company since 1948 as a sales engineer.

Before joining Eaton, Green was a project engineer for the Chrysler Corp. and the Packard Motor Car Co.

ROBERT D. MORRISON, formerly a sales engineer at Eaton, has been made assistant sales manager of the coil spring department.

Morrison joined the production planning department of Eaton's Valve Division in 1940. He became a project engineer with the Spring Division in 1945 and a sales engineer in 1951.

WALTER C. CHAFFEE has been named director of engineering for Bennett Pump Division of John Wood Co. Chaffee comes to his new position from Keller Tool Co., Division of Gardner Denver Co., where he was a manager of the engineering department for five years.

Prior to this, he was president of his own engineering consultant company. He has also been associated with both Curtiss-Wright Corp. and Douglas Aircraft Co.

R. JOHN MOORE, president and general manager of Detroit Ball Bearing Co., has been elected to membership in the Young Presidents Organization. This is a national organization of men under 45 who were elected president of their respective corporations before they attained the age of 40.

CLARENCE G. BAUER has been appointed manager of quality control for the Stamping Division at Chrysler Corp. Prior to this new appontment Bauer had served as general manager for Chrysler Division since 1955.

Previously he was works manager, body car building, Chrysler Division, for six years. He joined Chrysler in 1931.

RINE KRUGER, JR., has been named assistant chief engineer in charge of all divisional battery engineering activities for Delco-Remy Division, General Motors Corp. He has directed Delco-Remy's battery engineering since August, 1955.

Kruger joined the division in 1949 at the Anderson plants as a student engineer. In 1950 he transferred to the Delco Battery plant at Muncie, Ind., where he performed various assignments in the battery laboratory and statistical work in the engineering department.

Two years later he became a member of the battery production engineering section and in 1954 was named assistant battery engineer.

F. A. STEWART has been named to the newly-created position of production control manager at the Chrysler Division, Chrysler Corp. Since 1955, Stewart has served on the staff of the division's president.

He joined Chrysler Division as a resident engineer in 1953.

BERNARD H. HERSHKOWITZ has joined North American Aviation, Inc. as senior research engineer, powerplants section. Previously, he was assistant director of research at the B. G. Corp., Ridgefield, N. J.

LOUIS M. BLANCHETTE, previously managing engineer, advanced chassis design, central engineering, Chrysler Corp., has been made resident engineer at the Indianapolis plant for Chrysler.

Blanchette served as adviser for the SAE Student Branch at the University of Detroit in 1955-1956.

MAX COUNTS, formerly with Sperry Farragut Co., is now an assistant project engineer with Universal Moulded Products Corp., Bristol, Va.

WILLIAM F. LITTLE (right), retiring president of Electrical Testing Laboratories, Inc., accepts a nautical clock from Hoffman S. Beagle (left), executive vice-president of Electrical Testing Laboratories, at a banquet held in his honor.

Little joined Electrical Testing in 1903 and has been with the company ever since with the exception of a four-year period from 1906 to 1910 when he served as manager of the Victor Instrument Co. He was elected to the presidency of ETL in 1953.

DR. J. BENNETT HILL, pioneer oil industry chemist, has retired as director of Sun Oil Co.'s research and development department.

Hill has helped manage Sun's research program for the past 22 years. He joined the company in 1934 as manager of the Development Division, manufacturing department. He directed oil research for the Atlantic Refining Co. for 11 years prior to joining Sun.

In 1948, when Sun's research and development department was formed, Hill was named director of that department's Chemical and Engineering Division. He became director of research and development in 1952.

DR. CHARLES L. THOMAS will succeed Hill as director of the department. He formerly was associate director of research and development.

Thomas is well known in the oil industry as the author of more than two dozen articles and over 100 patents.

He joined Universal Oil Products as a research chemist, and later was appointed associate director of research. He left UOP in 1945 to become director of research with Great Lakes Carbon Corp.

Starting with Sun in 1951 as a staff assistant in the research and development department, Thomas was named associate director of the department in 1953.

MUNDY I. PEALE, president of Republic Aviation Corp., has been elected president of the Institute of the Aeronautical Sciences for 1957. He is the 25th president of the institute.

EDWIN E. ALDRIN, aviation consultant to Standard-Thomson Corp., was elected a vice-president of the institute.

ROY E. MARQUARDT, president of Marquardt Aircraft Co., also was elected a vice-president of the institute.

VIRGIL H. KNOWLES has been appointed district manager of the Denver branch office of Mack Trucks, Inc.

Prior to joining Mack in the later part of last year as a special sales representative, he was West Coast Division sales manager for Fruehauf Trailer Co.

JACK I. HAMILTON, previously general sales manager, Menasco Mfg. Co., has been named vice-president of sales for the company.

GLENN E. VESCELUS, who was director of engineering for Menasco, is now vice-president of engineering for the firm.

G. REUTER has been named assistant director of engineering at the Bucyrus-Erie Co., South Milwaukee, Wis. Prior to this new appointment, he was in charge of tractor equipment at Bucyrus-Erie.

D. J. LaBELLE has been appointed truck engineer, Truck and Coach Division, General Motors Corp. Formerly, he was senior project engineer for the division.

Since joining GMC in 1939, he has served as assistant truck engineer in charge of new development, structure and suspension development engineer, and senior project engineer.

JOSEPH T. CLARK, JR. is now a plant superintendent for Leece-Neville Co., Cleveland. Formerly he was general foreman, development, for Leece-Neville.

JOHN B. MASTIN has joined the Min-A-Con Equipment Co. as sales engineer for industrial accounts. Formerly, he was a product development engineer for International Harvester Co.

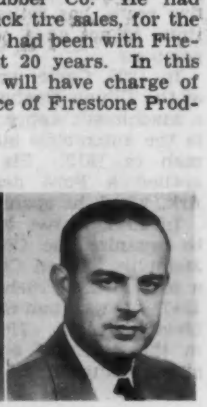
DR. ARTHUR NUTT, SAE president in 1940, and currently vice-president, engineering, for Lycoming Division, Avco Mfg. Corp., addressed engineering students at the University of Connecticut on engineering education. His talk was presented as the 15th PiTauSigma Lecture, PiTauSigma being the national honorary mechanical engineering fraternity.

NEWELL T. PALMER has been made resident manager, Alaska, Firestone Tire & Rubber Co. He had been manager, truck tire sales, for the company. Palmer had been with Firestone for the past 20 years. In this new capacity, he will have charge of all sales and service of Firestone Products in Alaska.

Hamilton

Vescelus

Reuter



LaBelle

LOUIS C. LUNDSTROM, formerly assistant director of General Motors Corp.'s Proving Grounds, has been named director of the Proving Grounds.

Lundstrom joined the Proving Ground staff at Milford as a test engineer in 1939 and three years later he was made a project engineer.

In 1947, Lundstrom was named mechanical department head, and in 1953 he became assistant to the director of the Proving Grounds.

H. C. RIGGS has been named coordinator of missile applications engineering by Exide Industrial Division of the Electric Storage Battery Co., Philadelphia. Previously, manager of Exide's Engineering Development Division, Riggs now spearheads the company's expanded developmental program for the production of missile battery power units.

L. H. DIEHL, JR., vice-president and director of Detroit Gasket & Mfg. Co., will now head the Automotive Division operations of the company. **RUSSELL A. BLANCHARD**, formerly general sales manager for Detroit Gasket, has been named vice-president of the company's Extruded Metal Division.

LeROY CHESTER ZASTOVNIK is now a technical engineer with Aircraft Gas Turbine Division, General Electric Co. Formerly, he was an analytical engineer with Pratt and Whitney Aircraft Division, United Aircraft Corp.

JOHN McHUGH has been named chief engineer, vehicles, Leyland Motors, Ltd. His previous position was chief engineer for Leyland Motors (Canada), Ltd. McHugh had been with Leyland for 30 years.

J. G. WEAVER is now a product engineer with Aeroguild, Inc., Roseville, Mich. Previously, he was a senior product engineer, aircraft section, Houdaille-Hershey Corp.

ABRAHAM SMAARDYK has rejoined Argonne National Laboratory as an associate mechanical engineer in the Reactor Engineering Division. From 1948 to 1955, Smaardyk was associated with Argonne and since then has been associate director of the nuclear engineering department at Edward Valves, Inc.

JOHN WILLIAM MOULES is now a test engineer with Chrysler Corp. Prior to joining Chrysler, he was a test engineer with International Harvester Co.

J. CHRIS GREEN is now a project engineer with Electro-Motive Division, General Motors Corp. Formerly, he was a design engineer with Collins Radio Co.

ALAN R. CRIPE, director of design for Chesapeake & Ohio Railway Co., Cleveland, addressed the opening fall meeting of the Detroit chapter of Industrial Designers' Institute on "Transportation Design in Europe."

Cripe was one of a three-man team representing the Design Directors in Industry group who toured Europe and Scandinavian countries last Spring to study design methods of private and company designers in all phases of industry.

GEORGE E. ENGELMANN has been appointed executive assistant to the president of Mack Trucks, Inc. Since February, 1955, he has been manager of Mack's Government Division in Washington, D. C.

Englemann has had 24 years of experience in the automotive industry, including trucks as well as passenger cars.

A. KING McCORD has been named president of the Westinghouse Air Brake Co., Pittsburgh. Previously, he was president of the Oliver Corp. in Chicago.

THOMAS G. TAXELIUS has joined the Bettis Plant, atomic power research laboratory which Westinghouse Electric Corp. operates for the Atomic Energy Commission. Previously, he was a technical writer for Military Manuals Co., in Renton, Wash.

Taxelius will work as a technical writer on the atomic powered surface ship projects.

AYDIN CANSEVER has joined the Raymond Concrete Pile Co. of Delaware as assistant mechanical supervisor. Previously he was research engineer at Sloan Automotive Laboratory in Cambridge, Mass.

PROF. HEINRICH BUSCHMANN (left) of Stuttgart, Germany, received a certificate of membership in SAE from the hands of **PROF. P. H. SCHWEITZER** recently. The presentation was part of a delayed celebration of Prof. Buschmann's seventieth birthday last August 12 arranged by some of his friends in this country, including Profs. Schweitzer and **A. W. HUSSMAN**, and **W. E. MEYER**, all of The Pennsylvania State University. Prof. Schweitzer has been touring Germany and took part in the dinner held in Stuttgart for Prof. Buschmann.

Prof. Buschmann teaches several subjects at the State Engineering School in Esslingen although he "retired" in 1952. Also he edits "Motortechnische Zeitschrift" ("MTZ"). He relinquished the editing of "Automobilitechnische Zeitschrift" ("ATZ") in 1954. He is well known in European engineering circles not only for his teaching and editorial activities but also for the leading part he played in the design of Daimler-Benz and Magirus trucks in the decade after his graduation from the Institute of Technology of Stuttgart in 1911.

His extensive professional activities have not prevented him from serving on civic projects. Over the years, he was elected to the county and city councils and to the board of overseers of his church, honors which he still holds.

Willcher Receives Highest Civilian Award

MEYER HOWARD WILLCHER (center), supervisor production analyst, Japan Ordnance Command, was presented with the highest civilian award, the Exceptional Civilian Service Medal by Maj.-Gen. Albert Pierson (left), chief of staff, Army Forces Far East and Eighth Army (Rear). Col. D. N. Black (right), chief, Maintenance & Supply Division, represented Brig.-Gen. H. F. Bigelow, Ordnance Officer, Army Forces Far East and Eighth Army (Rear).

Willcher's commendation, signed by the Secretary of the Army, reads in part: "His many outstanding and practical contributions in the field of Ordnance production, with particular emphasis on emergency field expedients and procedures appropriate to indigenous application, greatly expedited the availability of Ordnance equipment to United Nations troups during combat and have resulted in substantial savings of government funds reflecting great credit to himself and the Army establishment."

Before coming to the Far East, Willcher was employed by the office of the Quartermaster General in Chicago where he wrote catalogues on parts interchangeability.

HOWARD E. BRAMM is now a design engineer with Rohr Aircraft Corp., Chula Vista, Calif. Formerly, he was a design engineer for Frye Corp., Fort Worth, Texas.

EUGENE W. WASIELEWSKI has become manager, Quehanna altitude facility department, for the Wright-Aeronautical Division of Curtiss-Wright Corp. Formerly, he was assistant director of Lewis Flight Propulsion Laboratory, NACA, Cleveland, Ohio.

HERBERT I. CHAMBERS has been appointed chief development engineer for Consolidated Electrodynamics Corp. He had been supervisor of electro-mechanical development for the firm.

Prior to joining Consolidated Electrodynamics in 1954, Chambers was supervisor of new product development for Electric Auto-Lite Co.; senior mechanical designer, Strong Electric Corp.; senior tool engineer, Electric Auto-Lite Co.; and tool designer, Toledo Scale Co.

CLARENCE KELLY, JR., previously a sales engineer with Cooper-Bessemer Corp., is now a project engineer with the Stearns-Roger Mfg. Co., Denver, Colo.

Kelly will coordinate the engineering and construction of oil and gas industry installations for the firm.

JOHN MODELL, JR. has been appointed manufacturing manager for the Progressive Welders Sales Co. Formerly, he was prototype manufacturing manager in the Government and Industrial Products Division of the Studebaker-Packard Corp.

ABRAM D. REYNOLDS is now in charge of executive sales, automotive accounts, at Reynolds Metals Co., Detroit. He had been industrial sales manager for Reynolds Metals.

JOHN F. PEYTON has been named chief engineer at Arrowhead Products Division, Federal-Mogul-Bower Bearings, Inc., Detroit. Before joining Arrowhead, he was chief engineer at Airite Products, Los Angeles.

E. N. COLE, general manager for Chevrolet Motor Division, General Motors Corp., addressed engineering students at the University of Michigan on "Challenges Unlimited for Young Engineers."

Cole listed nine areas which he feels offer the greatest potential. Included are new powerplants and transmissions for cars, synthetic fuel, new metals or metal-like materials, more synthetics, nuclear energy for research and testing, use of mechanical brains, and safety engineering.

ARTHUR J. R. SCHNEIDER has joined Waste King Corp. as chief technical engineer. Before joining Waste King, he was a research engineer at the Naval Ordnance Test Station, Pasadena, Calif.

CHARLES F. GOTSCHALK has joined Solar Aircraft Co. as experimental engineer. Prior to joining Solar, Gotschalk was with Wright Aeronautical as development engineer doing engineering analysis work on two-spool turbojet engines.

W. G. MYERS, formerly military sales manager for the Georgia Division of Lockheed Aircraft Corp., has been appointed director of military sales for the division.

Myers joined Lockheed in 1941 and has held positions in the company's offices at Burbank, Calif.; Dayton, Ohio; Chicago, Ill.; and Washington, D.C. He joined the Georgia Division in February, 1951, as contracts manager.

RAYMOND HUFFORD is now a registered patent agent in Culver City, Calif. Formerly, he was a patent examiner at the U.S. Patent Office, Department of Commerce, Washington.

JACK ROSENQUEST, previously head of the sales training school for Mack Trucks, Inc., has been appointed national used truck manager for Mack Trucks, Inc. Prior to joining the Mack organization, he served for many years as branch manager and division manager at Autocar Co.

Correction

In a story on page 92 of the "About SAE Members" section of the December issue, SAE Journal erroneously stated that Bamboo Ram (Bob) Teree "has been appointed chief engineer of Greer Hydraulics, Inc., Jamaica, N. Y.

The holder of that position is Baboo Ram (Bob) Teree.

MALCOLM P. FERGUSON, president of Bendix Aviation Corp., Detroit, has been elected chairman of the board of governors of Aircraft Industries Association for the period of Jan. 1 to June 30, 1957.

WHITLEY C. COLLINS, president of Northrop Aircraft, Inc., Hawthorne, Calif., was elected to the chairmanship of the association's board for the period July 1 to Dec. 31, 1957.

EUGENE W. JACOBSON, chief design engineer, Gulf Research and Development Co., has been elected technical director of the American Society of Mechanical Engineers.

WALTER F. WHITEMAN, formerly a product engineer with Standard Steel Spring Division, Rockwell Spring & Axle Co., is now a stress analyst at Allis-Chalmers Mfg. Co.'s Buda Division.

Whiteman was honored recently at an SAE Chicago Section meeting where he received a 25-year membership certificate.

WARREN CHARLES REYNOLDS is now a research engineer in the scientific laboratory for Ford Motor Co. Prior to joining Ford, he was a maintenance officer with the Department of the Air Force.

JOSEPH J. CIESLA has joined the Dilts Division of the Black-Clawson Co. in Oswego as a designer. Prior to this position, he was a designer with Chance Vought Aircraft, Inc., in Dallas, Texas.

R. H. WILLIAMS has been named general manager for Neal Motor Sales, Inc., Corpus Christi, Texas. Formerly, he was regional truck manager for the Ford Motor Co. in Dallas.

SCOTT M. KENNEDY, director of sales, Parts Division, Aluminum Industries, Inc., has been elected vice-president in charge of the division.

Obituaries

THERON BRADSHAW

Theron Bradshaw, former chief engineer of the Replacement Division for Perfect Circle Corp., died Oct. 3. He was 65 years old.

Bradshaw retired to Claremont, Calif., early in 1956 after 21 years with Perfect Circle. He joined the company in 1935 as service manager after four years with Colyear Motor Sales Co., Los Angles. Prior to that, he was owner of The Piston Ring Shop. During World War I, he was a first sergeant with an Army motor truck company and served overseas. He was awarded two bronze stars.

Bradshaw had been a member of SAE since 1941, and for many years was closely associated with race car engineering.

PARRY H. PAUL

Parry H. Paul, sales engineer of the Autocar Division of the White Motor Co., Exton, Pa., died on Nov. 4.

Born in Moorestown, N.J., he attended Swarthmore College for one year, then went on to graduate from the University of Wisconsin, College of Engineering.

A veteran of World War I, Paul later went to Russia for a year with the Friends' Service Committee under the Hoover Commission. He organized a tractor school for training young Russian boys to use and service tractors sent over for their use. Returning to the United States, he lectured for some time on his experiences in Russia.

Paul joined the Autocar Co. in Ardmore, Pa., in 1937.

He became a member of the SAE while still in college, receiving in 1952 a certificate of "more than 25 years active membership." He served as chairman of the Philadelphia Section in 1948–1949.

Paul was a member of the Antique Automobile Club of America and served as an early vice-president in the Philadelphia Main Line area. In June, 1951, his article on "The Autocar of 1898" appeared in *The Antique Automobile*, the club's publication.

ROY H. DAVIS

Roy H. Davis, president of Atlas Steels, Ltd., Ontario, Canada, died in June, 1956. He had been a member of SAE since 1937. Davis was graduated from the U.S. Naval Academy in 1909, and did postgraduate work in Naval Ordnance from 1911 to 1913.

In 1913 he joined United States Coal and Coke Co. as a mechanical and electrical engineer. Two years later he was named assistant to the vice-president, Washington Steel and Ordnance Co., New York City. In 1917 he was appointed general manager of the Firth Sterling Steel Co. at McKeesport, Pa.

From 1923 to 1928 he was manager of the Parks Works of Crucible Steel Co. of America in Pittsburgh. He was made president of Atlas Steels, Ltd. in 1928.

HARVEY S. KING

Harvey S. King, principal inspector at the Port Washington Division of Republic Aviation Corp., died July 5. King began in the engineering field in 1942 at Grumman Aircraft Engineering Corp. Prior to that time he had been the owner of a musical instrument shop.

During World War II he served in the U.S. Navy, Naval Air Transport Command. He joined Republic in 1945 as an inspector and was made principal inspector in 1956.

SIR RICHARD FAIREY

Sir Richard Fairey, British aviation pioneer, and chairman and managing director of Fairey Aviation Co. Ltd., died on Sept. 30. Fairey attended Merchant Taylors' School and Finsbury Technical College. He began in industry as manager of Blair Atholl Aeroplane Syndicate in 1911. Two years later he joined Short Bros. Ltd., as chief engineer. In 1915, Fairey became managing director of Fairey Aviation Co. Ltd. Under his direction the company was the first British firm to build all-metal planes. He is also credited with inventing the wing flap.

Fairey had been a member of SAE since 1926 and also was a fellow of the Royal Aeronautical Society.

JOSEPH B. KAPLAN

Joseph B. Kaplan, vice-president of Lincoln Oil Co., died on June 9. He had been with Lincoln Oil since 1931, when he joined the company as a sales engineer. In 1935 he advanced to manager of operations and 10 years later was made sales manager. He had held the position of vice-president since 1949. Kaplan was graduated from Massachusetts Institute of Technology in 1925 and shortly after joined Skelly Oil Co. in the Refining Division. The next five years, until he joined Lincoln Oil, were spent in sales promotion for Skelly Oil.

NEWS OF SAE

SAE Manufacturing Men Wrestle With Human Relations, New Tools

A SURVEY of 22 manufacturing men in the automotive industry just completed by the SAE Production Activity indicates their most pressing day-to-day problems are in dealings with other people.

In three areas—management, communications, and training—production men are eager to learn how to handle people better, how to get the most work out of them, and how best to develop their latent abilities. Of those who indicated relative importance, half felt that the Production Activity Committee should give top priority to development of papers on communications and human resources.

People Are Problems

Fifty percent (11) of those who answered the survey want information on how to prepare engineers for management jobs. They want to know about existing management training programs (such as Westinghouse's) and how to determine which engineers have the proper aptitude for executive training. (It should be noted that most of the men surveyed were top manufacturing executives, so their concern with personnel is perhaps more intense than that of the average SAE member.)

Production men are also seeking for ways to develop better technical and human skills on lower personnel levels; supervisors, foremen, and workers. For instance, 7 of the 22 want to know how more ability (and therefore more productivity) can be obtained from the available labor supply. Training programs and apprentice systems are particularly pertinent. The problem from top management down is to make the most efficient use of the available talents and not waste people who have high level skills on low level jobs.

How Do You Talk To Them?

Manufacturing men feel that having skilled workers and managers is only part of the solution. They must be able to communicate with and among each other. All aspects of inter-personal contact, from memos to conferences, need enlightenment.

Although most everyone has some idea what is good and what is bad communication, no one has yet come up with a scientific factual approach to the problem. Basic questions:

- Are oral or written communications more effective?
- How many facts can a person be expected to absorb?
- How much repetition is necessary and how much is redundant?
- Is a "telegraphic" language practical?

An investigation into general information theory, based on psychology and sociology, will probably be necessary before principles can be stated from which practical applications can be derived.

In the meantime, manufacturing men are looking for specific ways of improving in-plant communications, of reducing communication costs, of specifying drawings and blueprints, of speeding up and simplifying manufacturing reports. They want to know when to write and when to speak and when to do both. (Half of those surveyed wanted to know when a written communication must follow an oral one.)

Emphasis on Management

There seems to be a definite desire for information of a non-technical—management nature. This is probably due to an increase in the percentage of SAE members who are becoming manufacturing executives. As always, they are looking for new ways to cut costs in manufacturing and maintenance. They're trying to do things faster so that the man-hours per job (which are the largest part of the costs) are reduced. Management expects further automation will supply solutions but they want more current information about when to automate, how to evaluate automation proposals, how to retain flexibility while automating, and how to use new electronic computers for controlling production.

New Tools Look Promising

Looking to the future, production men are eager to adopt new tools and methods. They want more information about ceramic cutting tips, the new carbide grades of tool-steel, plastic tooling, and "cookie cutter dies." They seek ways to cast new, high-strength, light-weight materials such as titanium. They're interested in vacuum melting and casting and the use of powdered metals in the automotive industry. And they want specific tips on how to increase tool life and what type of tooling is best for particular jobs.

How To Make It

There is continued interest in high temperature materials and necessary changes in machine tools and techniques to work these

materials. Production men are extremely interested to know the latest about numerically controlled machines, how to machine radioactive materials, how to use high-speed tools, and more about the "building-block" concept.

How To Make It Good

Quality of product continues to be of prime concern. Manufacturing men want to be kept up to date on new automatic inspection devices. Particularly in the aircraft industry there is a need for quality control specifications, training, and procedures which will insure thorough reliability. In the ground vehicle industry, production men are fighting for less stringent tolerance specifications unless they are absolutely necessary.

Putting It Together

Of those surveyed, there was an overwhelming interest in automatic assembly methods and powered assembly tools. A special interest is how to assemble precision instruments. Also, they want to know more about welding techniques for high tensile steels and the use of carbon dioxide gas shielded automatic welding. Nine of the 22 surveyed want to know how to regulate work flow automatically, and how to use electronic computers for production control.

There's interest, too, in getting the materials to the assembly line and taking the scrap away efficiently. Production men want to know what's new in conveyors, and how to salvage and dispose of scrap and waste materials. Plant services such as air conditioning, tool room procedures, corrosion prevention, and interplant transportation present problems that need to be solved, too.

Overseas Developments

SAE manufacturing men are awake to engineering developments that are happening overseas, particularly in Europe. They feel that there is much to be learned from countries like Germany and they want to know what they must do to remain competitive. Specifically, they'd like to know how American productivity compares with European and what production techniques can be adopted by American industry to reduce scrap materials.

SAE National Meetings . . .

1957

March 5-7
Passenger Car, Body, and Materials Meeting
The Sheraton-Cadillac
Detroit, Mich.

March 20-22
Production Meeting and Forum
Hotel Statler, Buffalo, N. Y.

April 2-5
Aeronautic Meeting
Aeronautic Production Forum
and Aircraft Engineering Display
Hotel Commodore, New York, N. Y.

June 2-7
Summer Meeting
Chalfonte-Haddon Hall
Atlantic City, N. J.

August 12-15
West Coast Meeting
Olympic Hotel, Seattle, Wash.

September 9-12
Tractor Meeting and
Production Forum
Hotel Schroeder, Milwaukee, Wis.

October 1-5
Aeronautic Meeting,
Aircraft Production Forum,
and Aircraft Engineering Display
Ambassador, Los Angeles, Calif.

November 4-6
Transportation Meeting
Hotel Statler, Cleveland, Ohio

November 5-6
Diesel Engine Meeting
Hotel Statler, Cleveland, Ohio

November 6-8
Fuels and Lubricants Meeting
Hotel Statler, Cleveland, Ohio

1958

January 13-17
Annual Meeting and Engineering Display
The Sheraton-Cadillac and Statler Hotels
Detroit, Mich.

SAE CEP
COOPERATIVE ENGINEERING PROGRAM NEWS

Bekker Reviews Work of Land Locomotion Lab

IN outlining the work of the Land Locomotion Research Laboratory at Army Ordnance Corps' Detroit Arsenal, M. G. Bekker gave these samples of current studies at the lab:

- Establishment of seven physical constants of soil: two related to strength of soil (friction and cohesion), four related to the deformation of soil (two moduli of deformation for sinkage and two for slippage), and an exponent of the change of stress-strain relationship with the depth of soil mass has been introduced.

- Formulas to determine (a) drawbar-pull of pneumatic tires and tracks, (b) slip-pull characteristics of vehicles, and (c) grouser and tread effect upon drawbar-pull.

- Methods enabling one to produce a desired increase in the drawbar-pull of tractors and to predict vehicle performance in the given soil before the vehicle is designed or tested.

New general conclusions have been formulated in regard to the present state of the art of vehicle development and the possible lines of attack in the future. It appears that present trends have reached the levelling of part of the curve. New trends need revision of the "high flotation" principle which so far has led to an increase of tracks and wheels only, Bekker said.

Bekker, who is technical director of the laboratory, made the report at an all-day meeting of the SAE Off-Highway Vehicle Mobility Advisory Committee held December 11 at the Arsenal.

The meeting gave Committee members a chance to see the Laboratory's facilities and to hear about progress in soil mechanics from several of the experts associated with the work of the Laboratory. They also saw motion pictures of tests performed with a spaced-link-track vehicle at Aberdeen Proving Ground.

M. G. Bekker explains the method and equipment for determining motion resistance of pneumatic tires to men attending the all-day meeting of the SAE Off-Highway Vehicle Mobility Advisory Committee held December 11 at the Land Locomotion Research Laboratory, Detroit Arsenal.

Temperature Control Important to Accuracy

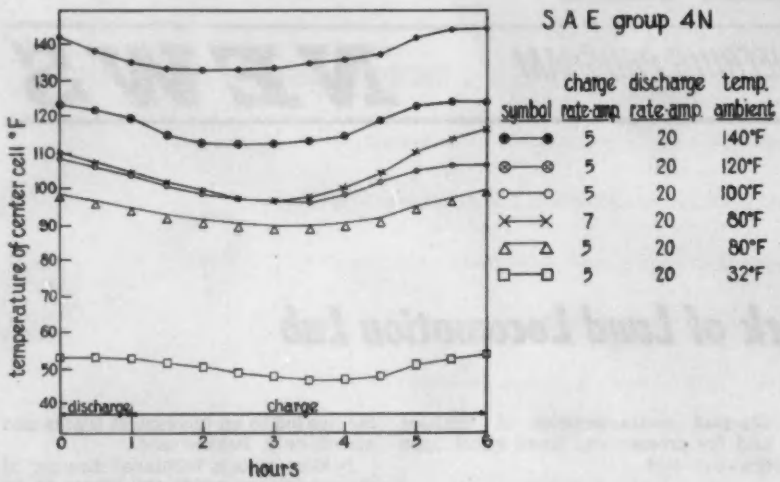


Fig. 1—Typical temperature variation under conditions investigated. Shows battery temperature during discharge-charge cycle at the ambient temperatures at which the batteries operated.

WHILE widely accepted, the SAE cycling test for battery life has given inexplicable variance in results in spite of careful sample preparation. With the advent of 12-v batteries the unexplained variation was even greater than with 6-v types. The results were also at a lower level than would be expected.

Now it appears that discrepancies were due to lack of control of ambient temperature, C. H. Endress of Electric Storage Battery Co. has reported to the SAE Storage Battery Sub-Committee.

Six-volt batteries run in ambient air at normal room temperature generally yield the specified

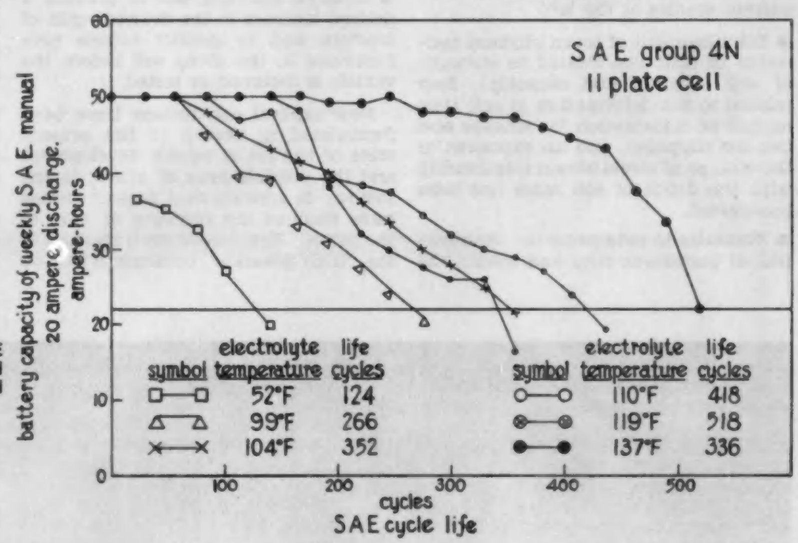


Fig. 2—Capacity measurements during SAE cycle test show the capacity values obtained during test, and the number of cycles obtained at each ambient temperature.

# of Battery Life Test

temperature. When temperatures of 12-v batteries operated in ambient air were measured, they were observed to be approximately 10 F cooler.

Six pairs of duplicate 4N 55-amp-hr batteries were built as nearly identical as possible. Each pair was subjected to cycle life at six different temperature levels.

Figs. 1–3 show data Endress gathered with J. F. Macholl and A. G. Koch of Electric Storage Battery Co. The data make clear the importance of temperature control. Even within the SAE limits we can expect to obtain a range between 350 and 470 cycles, depending on the temperature range in which the batteries were operated.

Inspection of batteries operated at the four lowest temperature ranges indicated positive plate shed. The batteries operated at 120 and 140 F failed because of negative sulfation.

The data clearly indicate that the cycling test is highly influenced by temperature. Further, at temperatures of 120 F or higher the negative plate plays the predominant part in ultimate failure.

The test indicates that ambient temperatures must be closely controlled to the ±5 F limits specified by SAE, and closer than ±5 F if possible.

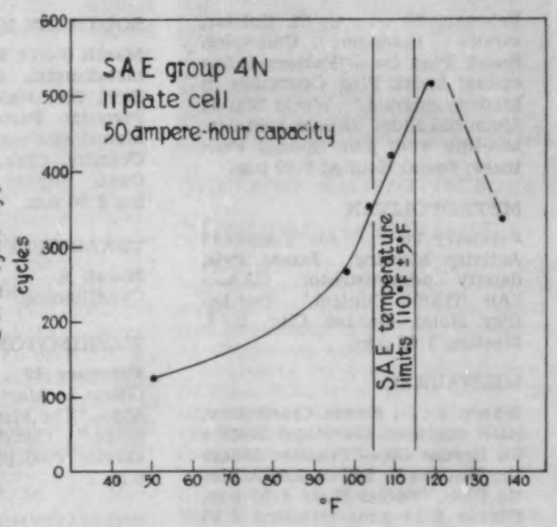


Fig. 3—Relationship between SAE cycle life and temperature shows the steep slope of the curve even within the SAE-established limits of 110±5 F.

CRC Studies Octane Requirements and Ratings

RELATIONSHIP between antiknock performance of fuels and vehicle octane-number requirements is undergoing further study according to report (CRC-293) "Correlation of Road Antiknock Ratings in Octane-Number-Requirement Survey Cars and Test Cars."

Primary reference fuels and full-boiling-range gasolines with sensitivities similar to commercial gasolines are tested on two 1953 makes of cars by the Road Rating Exchange Panel and compared to results obtained by the Survey Panel on these cars using the same fuels.

Road octane ratings are made by the Modified Borderline Method and the Modified Uniontown Technique by relating road ratings and octane requirement data at the same engine speed.

Results of these tests show that:

1. Either the Modified Borderline or the Modified Uniontown Technique can be used to predict, with reasonable accuracy, the antiknock characteristics of fuels in customer cars.

2. The average Modified Uniontown rating in cars of make 1 was 0.9 octane number higher and in car of make 2 was 0.2 lower than the average survey rating.

3. The average Modified Borderline rating in cars of make 1 was 0.6 octane number higher and in cars of make 2 was 0.3 higher than the average survey car rating obtained at the same engine speed.

CRC-293 contains 12 pp, including tables and graphs. It is available from SAE Special Publications Department. Price: $1 to members, $2 to nonmembers.

CRC Studies Effects of Diesel Fuel Variations

EFFECTS of variations in fuel properties on operation and maintenance of locomotive diesel engines under normal operating conditions are discussed in a CRC report (CRC-292), "Report on Full-Scale Field Service Tests of Railroad Diesel Fuels." Eight full-scale field service tests on the sulfur content, ignition quality, and end point of diesel fuels are completed. Each test is performed by comparing a test fuel with the railroad's normally used fuel in similar locomotives and under similar conditions. Thirty-four engines are operated under passenger, freight, switcher, and pusher service, half on test fuels and half on the control fuels.

In brief, these tests show that:

1. When considering only the sulfur content, cetane number, and end point as physical properties of the test fuels, it is possible to operate the locomotive diesel engines under study without sacrificing locomotive availability for service.

2. However, fuel properties other than these, such as instability, high cloud, and pour points, may adversely affect locomotive operation or maintenance.

3. Due to wear or deposits, increased engine maintenance such as more frequent change-out power assemblies may be necessary when using fuels of the type being tested. But this depends on the nature of the test fuel used, the nature of the locomotive operation, and maintenance practices.

4. The overall approach to testing used in this project seems to be a valid means of determining the effect of variation in fuel properties on railroad diesel engines.

CRC-292 contains 381 pp, including illustrations, tables, charts, and graphs. It is available from SAE Special Publications Department. Price: $5 to members, $10 to nonmembers.

Section Meetings

ATLANTA

March 4 . . . Robert F. Rarey, Chrysler Engineering Division.—"Putting Plymouth V-8 Engine into Production."

BRITISH COLUMBIA

February 18 . . . R. W. Fredericks, regional representative, Champion Spark Plug Co., Seattle, Wash.—"Spark Plugs & Engines." Hotel Georgia, Vancouver. Dinner 7:00 p.m. Meeting 6:15 p.m. Special Features: Latest technical films on Spark Plug & Engine Development.

BUFFALO

February 19 . . . Symposium: Air Suspension Systems. Panel of Industry Representatives. Peace Bridge Motel. Dinner 6:30 p.m. Meeting 8:00 p.m.

CANADIAN

February 20 . . . W. Paul Eddy, 1957 SAE President.—"From Pistons to Jets."

CENTRAL ILLINOIS

February 25 . . . E. W. Spannhake, director of engineering & research, LeTourneau-Westinghouse Co., Peoria.—"Putting Engine Power to Work in Earthmoving Equipment." Caterpillar Tractor Co., Decatur, Ill. Dinner 6:15 p.m. Meeting 7:30 p.m.

CINCINNATI

February 25 . . . Norman R. Parmet, director of development engineering, TWA, Kansas City, Mo.—"The Impact of Jet Transportation." Cincinnati Club. Dinner 6:30 p.m. Meeting 8:00 p.m. Special Features: Film—"Mr. Withers Stops the Clock."

DETROIT

February 18 . . . 3 Sessions—1st Session: **W. A. Bonvallet,** General Motors Proving Ground, **Kurt A. Beier,** Schwitzer Corp., and **T. A. Robertson,** Firestone Tire & Rubber Co.—"Truck Noises, Inside and Out." 2nd Session: **Frederick Altman,** Fisher Body Division, GMC.—"New Techniques and Materials for Low Cost Tooling." 3rd Session: **B. J. Smith,** Lincoln Division, Ford Motor Co., and **George F. Macfarlane,** Mitchell-Bentley Corp. —"Trends in Body Types." Moderator: **S. L. Terry,** Chrysler Corp. Dinner Speaker: **Jack Alan,** K.L.A. Laboratories Inc. and Station WLDM-FM.—"HI-FI RAMA —The History of Recorded Music." Rackham Educational Memorial. Dinner 6:30 p.m. Meeting 8:00 p.m.

INDIANA

February 14 . . . C. I. Hodgson, plant sales manager, Doehler-Jarvis Division, National Lead Co., Toledo, Ohio.—"Recent Trends in Aluminum & Magnesium Die Casting." Indianapolis Naval Armory. Dinner 7:00 p.m. Meeting 8:00 p.m.

KANSAS CITY

February 21 . . . G. M. Galster, service manager, Champion Spark Plug Co.—"Factors Influencing Spark Plug Operation in Modern Engines." World War II Memorial Bldg. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Features: Social Hour at 6:30 p.m.

METROPOLITAN

February 20 . . . Air Transport Activity Meeting. **James Pyle,** deputy administrator, CAA.—"Air Traffic Control." Garden City Hotel, Garden City, L. I. Meeting 7:45 p.m.

MILWAUKEE

March 1 . . . Edwin Crankshaw, chief engineer, Cleveland Graphite Bronze Co.—"Practice Makes the Bearing." Milwaukee Athletic Club. Social Hour 6:00 p.m. Dinner 6:30 p.m. Meeting 8:00 p.m. Special Features: This paper will be published with a section on "Bearings & Bearing Lubrication" as part of "Engineering Know-How in Engine Design" Part 5.

MONTREAL

February 18 . . . Joint Meeting with Canadian Aeronautical Institute. **Dr. B. P. Leonard,** Convair. — "Nuclear Propulsion." Mount Royal Hotel. Dinner 6:30 p.m. Meeting 8:00 p.m.

PHILADELPHIA

February 13 . . . Ernest R. Sternberg, special products engineer, Autocar Division, White Motor Co., Exton, Penna.—"Developments in Off-Highway Vehicles." The Engineers' Club. Dinner 6:30 p.m. Meeting 7:45 p.m.

PITTSBURGH

February 25 . . . Warren Smith, research staff, Mechanical Development Division, GMC., Detroit.—"Free Piston Engines." Webster Hall, Mellon Institute. Dinner 6:30 p.m. Meeting 8:00 p.m.

SAN DIEGO

February 14 . . . T. R. Thoren, Thompson Products, Inc.—"Fuel Injection for Passenger Cars."

SOUTHERN NEW ENGLAND

March 6 . . . R. L. Strout, chief metallurgist, Standard Pressed Steel Co., Jenkintown, Penna.—Precision Fastener Materials & Manufacturing. Rockledge Country Club, West Hartford, Conn. Dinner 6:45 p.m. Meeting 8:00 p.m.

TEXAS GULF COAST

March 8 . . . "Automotive Air Conditioning."

WASHINGTON

February 19 . . . Werner Hess, Glenn L. Martin Co., Baltimore, Md.—"The Martin P6M Jet Seaplane." Occidental Restaurant. Dinner 7:00 p.m. Meeting 8:00 p.m.

WILLIAMSPORT

March 4 . . . Williamsport Moose Auditorium. Dinner 6:45 p.m. Meeting 8:00 p.m.

TWIN CITY

February 13 . . . C. L. Eksergian, executive engineer & assistant to president, The Budd Co., Philadelphia, Penna.—"Development & Characteristics of Disk-Type Brakes." Hasty Tasty Restaurant, Minneapolis. Dinner 6:45 p.m. Meeting 8:00 p.m.

SECTIONS

FEBRUARY 1957

SAE Applicants in 1956 Second Highest in History

Data from SAE Membership Department indicates that the calendar year from January through December, 1956, had the second highest record for number of applicants received in the history of the Society. The percentage of increase over last year was 6.5%.

Breaking it down by Professional Activities, the greatest percentage of increase of applicants for the year was in Tractor and Farm Machinery activity with a 39% increase. Passenger Car Activity was second with a 30% increase in applicants over last year.

An analysis of the increase of applicants by Divisions—Featherweight (membership less than 100), Welterweight (membership 100–199), Middleweight (membership 200–499), and Heavyweight (membership 500 and up)—shows that for the first seven months the Section year the Welterweight and Middleweight Divisions had the greatest increase with a growth index of 7.8, based on applications per 100 members.

San Diego Section, in the Middleweight Division, paced the field of new applicants with a 16.2 growth index. British Columbia, in the Featherweight Division, followed with a 15.8 growth index.

Other Sections and Groups reporting a growth index of 10.3 or over were, in order:

Central Illinois
Kansas City
Williamsport
Atlanta
Mohawk-Hudson
Salt Lake

Out-of-Section applications received for a seven month period to December 31 totaled 124.

Central Illinois

T. W. Head, Field Editor

Section Examines Student Activities

An examination by the Central Illinois Section reveals that although 130 students are involved in SAE activities, potentially more could be served by stepped-up action.

At present the Section administers a Student Branch of about 80 at the University of Illinois, Champaign, under Professor W. L. Hull and Student Chairman James Suhre, and a second Student Branch of about 50 at Bradley University, Peoria, under Professor Max Wessler and Student Chairman John Berbracht. In Champaign there are virtually no Section members employed in industry; while Peoria, on the other hand, is the center of about 75% of the Section membership.

The students organize in the fall for all practical purposes, and function throughout the school year, with a new set of officers for each semester. They have monthly meetings with a speaker or movies from industry, followed by refreshments. The Bradley Student Branch conducts an automobile economy-run contest for its members; it attracts a large number of entrants, and much interest, perhaps because of its non-scholastic nature.

Each spring the Central Illinois Section at a regular meeting hears papers prepared and presented by two students from each Student Branch, and awards cash prizes. The Section also organizes members to serve as paying hosts to students at regular dinner meetings. In addition the section contributes $50 per year to each Student Branch for SAE activities.

Effective as the Student Branches have been, there remain a number of problems; their fall meetings lack adequate planning, the University of Illinois Branch is at a great distance from the bulk of the membership, and there is a reluctance of busy students to take on added responsibilities in SAE activities. As a result, few papers are submitted for the Section's contest, and too few students avail themselves of the opportunity to come as guests to Section meetings.

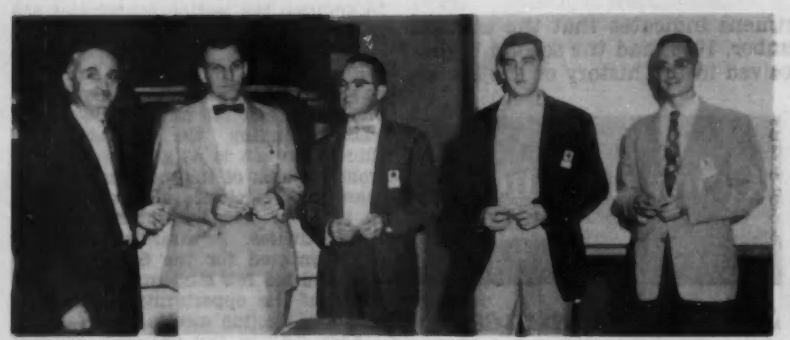
According to the Section's Student Activity Committee, an approach to the correction of these problems appears to lie primarily with the establishment of a larger, more active Student Activity Committee. A second step in this intensified Student program is to heighten the interest of members in attending student meetings (as well as providing an opportunity for increased guidance and understanding, it will be a chance for alumni to reminisce!) Such guidance could include encouraging the Student Branch to organize completely in the spring for the following fall, with the first meetings of the new term well planned in advance.

Such a committee could encourage publication of an SAE Student Branch newsletter, help plan economy runs and non-scholastic activities of this sort, and assist further in recommending outstanding speakers.

It is felt that the Student Branches in this way will be given encouragement in forming more and larger student committees, thus integrating more students into the Society.

Much of the above adds up to increased assistance for the Student Advisers—this help being essential to keeping good men in these all-important jobs.

Williamsport Group Program Chairman Blair S. Kratzer (right) introduces Dr. J. A. Kyger (left), project director, research and development, Avco Mfg. Corp., as guest speaker at the Group's December meeting.



At the same meeting, Group Chairman Allen Weiss (left) presents membership pins to four new SAE members. Left to right are: George Schramm, Robert McCumber, Fred Burnham, and George Lenington.

Williamsport

B. L. Sharon, Field Editor

Section Honors Young Scientists

The Governing Board of the Williamsport Group recently adopted a program to encourage the activity of high school science clubs.

It is felt that from these school activites will come the future engineers and scientists. The desire of the Board is to stimulate the interest and activity of these young people by each month inviting a student to be guest at a regular dinner meeting of the Williamsport Group.

There are five high schools in the Williamsport area which are eligible to participate. The plan is to have a school represented each month by a student chosen by the science club faculty adviser as a reward for outstanding activity or achievement. The schools will be taken in rotation so that each will have the same opportunity to participate.

These young people will meet men in the professional field which holds their interest and will be able to discuss with professionals a very important phase of their lives—their futures.

By this plan the Williamsport Group hopes to stimulate interest of young students in the fields of engineering and science.

From Student Cameras

Scene taken at the Texas A & M College campus where the Student Branch played host to the Texas Gulf Coast Section on Dec. 11. Members made the 100-mile trip for the annual visit by chartered bus.

Captain Emanuel M. Roth, USAF, Department of Space Medicine at Brooks Air Force Base, presented a talk on "The Medical Aspects of Space Travel."

Before the meeting got underway, principals posed for this Journal photo. Left to right are: Albert Willaert, student treasurer; R. F. Wilson, Texas Gulf Coast Section vice-chairman; Prof. W. I. Truettner, student sponsor; guest speaker Captain Emanuel M. Roth; Louis F. Mock, Jr., Texas Gulf Coast Section chairman; and Ernest Rickel, Student Branch secretary.

NORTHWEST

B. H. Murray, Field Editor

"Practical Brake Problems" was the title of a talk presented by Lee Ketchum of Brake Devices & Instrument Co. at the Section's Dec. 7 meeting. Charts were used to show the distances traveled at various speeds versus reaction time. In addition, there was a display of safety devices and breakaway kits.

The Nov. 9 meeting of Northwest Section featured a forum paper given by members of the Boeing Air Transport Staff entitled "Fire Protection Techniques in the Design of the Boeing 707 Jet Transport."

The discussion was broken down into four topics; Fire Prevention; Fire Control; Fire Detection; and Evacuation. **Edward Oslos** talked about the fuel system and the building of the tanks. **W. E. Bailey** discussed the sealing of the fuel tanks. **Robert Little** commented on the commercial performance potential of the Boeing 707. **Jerry Kauffman** spoke on the electrical system. **James Yates** discussed and demonstrated the procedures for rapid evacuation of the plane.

ST. LOUIS

F. H. Myers, Jr., Field Editor

Slides showing the American Bosch installations on the Lincoln, Mercury, and Packard engines were part of "The Gasoline Injection Story" as told by **Joseph Osterman**, field engineer, American Bosch Arma Corp., at the St. Louis Section's December meeting.

A discussion on the planned cost of the fuel injection system as opposed to conventional carburetion followed the formal talk.

Philadelphia

E. V. Henc, Field Editor

"Effect of Fuel Volatility on Starting and Warm-Up of New Automobiles" was the paper presented by **H. A. Toulmin** of the Ethyl Corp. at the December meeting of the Philadelphia Section.

The discussion, with complement of slides, was on the comparison of performance of various fuels, in cold starting and warm-up time, which was tested in several late model automobiles.

New England

George T. Brown, Field Editor

Irwin T. White, sales manager of Gradall Division, Warner & Swasey Co., was guest speaker at New England Section's Dec. 4 meeting. Highlighting the talk was a motion picture illustrating the various uses of the Gradall.

Preceeding the speech, a 25-year membership certificate was presented to **Joseph C. Whitcomb.**

KANSAS CITY

C. Abrams, Field Editor

Guest speaker for the Dec. 6 meeting of the **Kansas City Section** was **L. A. Ohlinger**, chief of computer services, Northrup Aircraft, Inc., who spoke on "Nuclear Power in the Air of Tomorrow."

BALTIMORE

D. E. Woomert, Field Editor

The problem of rail transportation provided much discussion at the Dec. 13 meeting of the Baltimore Section. Responsible for the stimulating meeting was **K. A. Browne**, director of research, Chesapeake & Ohio Railway Co., whose talk was "Railvan Development."

Northwest Section members engrossed in forum talks on "Fire Protection Techniques in the Design of the Boeing 707 Jet Transport" given by Boeing Air Transport staff at the Nov. 9 meeting.

PITTSBURGH

H. J. Grance, Jr., Field Editor

A Typical Day of a Guest

Pittsburgh Section officers have become famous for their "red carpet" treatment of speakers and other honored guests who visit the Section. SAE President George A. Delaney's official visit to Pittsburgh in November is a case in point.

1. President Delaney arrived early on the morning of Nov. 27 at the Greater Pittsburgh Airport. Here we see him being escorted to waiting cars by (left to right) H. J. Grance, Section field editor; A. E. Dible, Section secretary; President Delaney, Murray Fahenstock, Section archivist; and Court Wolfe, Section chairman.

The group proceeded to the Mellon Institute in the Oakland section of Pittsburgh. The cars followed a route which took them over the hills surrounding metropolitan Pittsburgh in order to give the honored guest an opportunity to observe the recent improvements and new developments in the city.

3. At the conclusion of the luncheon the group headed for the Gulf Research & Development Co. at Harmarville, Pa., which is approximately ten miles from Pittsburgh. Purpose of the visit was to give President Delaney the opportunity of inspecting Gulf's recently completed Automotive Engineering Laboratory.

Here we see President Delaney (center left) discussing Gulf's new chassis dynamometer with (left to right) H. A. Bigley, Jr., Section treasurer; J. E. Taylor, director, automotive engineering, Gulf Research & Development Co.; and H. O. Creazzi, head of the service section at Gulf Research.

Speaker in Pittsburgh Section

2. Following the visit to Mellon Institute, the party adjourned to the nearby University Club where the Pittsburgh Section Governing Board held a luncheon in President Delaney's honor. Here seated left to right are: E. P. White, Student Activities chairman; President Delaney; Chairman Court Wolfe; Joseph Gilbert, manager, Technical Committee Division of SAE; W. C. Weltman, Finance Committee chairman; and H. A. Bigley, Jr., Section treasurer.

4. After the tour of the Gulf Laboratory, they all returned to the Webster Hall Hotel for dinner and then crossed the street to the Mellon Institute Auditorium for the technical session.

Prior to delivering his talk, President Delaney had the pleasant task of presenting R. M. Welker, a past-chairman of the Pittsburgh Section, with a 25-year SAE membership certificate.

5. Pittsburgh Section is somewhat unique in that the dinner and technical session are held in different locations. President Delaney is shown here at the Mellon Institute Auditorium delivering his talk, "Designing an Automobile."

From Section Cameras

1. Featured speaker for the Dec. 4 meeting of **Western Michigan Section** was **Merle Bennett** of the International Harvester Corp. who spoke on, **"Earthmoving Equipment."**

Bennett is the newly elected SAE vice-president representing Diesel Engines.

2. Student Branch members from College of the City of New York, New York University, Stephens Institute of Technology, and Academy of Aeronautics, heard **1956 SAE President George A. Delaney** discuss the designing of an automobile at the **Metropolitan Section** Dec. 10 meeting.

After the meeting, approximately 260 members and students were guests of the Automobile Manufacturers Association at the National Automobile Show.

3. William Moranda (center right), Program chairman for **Northern California Section South Bay Division,** greets **Walter F. Isley** (center left), Continental Aviation & Engineering Corp., at the joint meeting of the Division and the Section on Dec. 12. Other members of the welcoming committee are **Ernest Starkman** (left), technical chairman of Diesel Activity for Northern California Section, and **Frank Jarrett** (right), South Bay Division chairman.

Preceding the talk, "The Application of Fuel Injection to Ordnance Gasoline Engines," there was a field trip to the United Air Lines Maintenance Base at San Francisco Airport. The tour included inspection of a DC-7 which was on the Flight line.

4. A view of the speaker's table at the Dec. 11 meeting of the **Mohawk-Hudson Section** shows left to right: **T. P. Kilgallen,** district supervisor, Interstate Commerce Commission, Albany, N. Y.; **P. E. Kezer,** vice-chairman and Program chairman for the Section; **G. M. Parker,** safety inspector, Interstate Commerce Commission; **John H. Dewitt,** superintendent of transportation, Eastern Division, Niagara Mohawk Power Corp.; **L. F. Smith,** Section chairman; main speaker **William J. Corr,** assistant director of service, Mack Trucks, Inc.; **M. J. Severino,** district manager, Mack Trucks, Inc.; **J. Barclay Potts,** chief, Motor Carrier Bureau, Public Service Commission, State of New York; **W. C. Palin, Jr.,** secretary for the Section.

Corr discussed "The Economics of Preventive Maintenance Applied to Motor Trucks."

BUFFALO

S. E. Leese, Field Editor

Awareness of the necessity of able leaders in Civil Defense and the engineer's role in this program was brought more sharply into focus at the Buffalo Section Dec. 11 meeting. Speaker for the meeting was **William M. Smith**, general manager, Rocket Division, Bell Aircraft Corp., who delivered what was, in effect, a charge to engineering professionals to assume leadership in the Civil Defense program.

MONTREAL

A. A. Larkin, Field Editor

Section Scores with First Ladies' Night

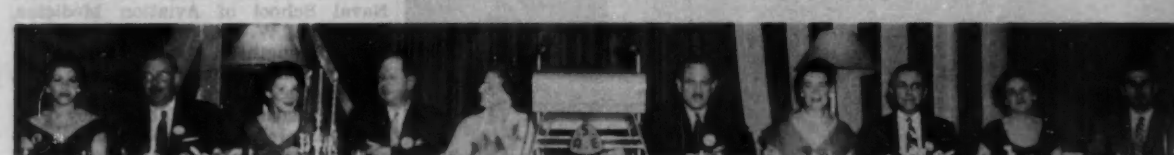
A big and very successful FIRST was scored by Montreal Section at their December meeting when the ladies were invited to a regular meeting. Montreal's first Ladies' Night was primarily a social function, but it also served the very practical purpose of letting the ladies meet the men with whom their husbands associate professionally, and of showing them how SAE meetings are conducted.

Chairman R. A. Harvey called the meeting to order in the usual way and after introducing the head table spoke briefly, for the ladies edification about the purposes and accomplishments of SAE. Then followed fun, food, and dancing.

Feature of the night was entertainment by Montreal's internationally known comedian-caricaturist Norman Hudon. Ten lucky ladies won very desirable prizes through ticket-draws and spot dances.

Montreal Section Chairman R. A. Harvey is shown here with his wife who carries the bouquet presented to her by the Section at its first annual Ladies' Night.

Catalystic capers are in full swing as members join hands with the female contingent for a chain dance at Montreal's Ladies' Night meeting.



Head table for Ladies' Night included left to right: Mrs. M. J. Bourgault; Section Past-Chairman A. E. Jennings; Mrs. Guy Blain; Arrangements Chairman Maurice Bourgault; Mrs. D. J. Munro; Section Chairman R. A. Harvey; Mrs. A. E. Jennings; Section Secretary D. J. Munro; Mrs. R. A. Harvey; and Membership Chairman Guy Blain.

From Section Cameras

Courtesy, Peoria Journal Star

1. Principals of the **Central Illinois Section** Nov. 29 meeting are left to right: Section Chairman **R. D. Henderson; A. L. London,** Department of Mechanical Engineering, Stanford University, who delivered a talk on the free-piston engine; and **W. A. Taussig,** who was awarded a certificate honoring his 25 years of active membership in SAE.

2. "Design Trends in 1957 Cars" was the topic of a talk presented by **Thomas A. Bissell,** manager, SAE Meetings Division, at the Dec. 6 meeting of the **Atlanta Section.** After the presentation, a question and answer period followed, with **Lester C. Malone,** Section vice-chairman acting as moderator.

3. **Col. Horace A. Hanes,** USAF, director of flight tests at the Air Force Flight Test Center, Edwards Air Force Base, spoke on the activities and facilities at the Base before a capacity turnout of approximately 250 members at a joint meeting of the **San Diego Sections of SAE and IAS.**

Shown with Col. Hanes (center right) are left to right: **Philip M. Klauber,** SAE San Diego Section chairman; **H. C. Matteson,** chairman of the San Diego Section of IAS; and **Joseph H. Famme,** technical chairman for the evening's meeting.

Klauber has been named chairman of the San Diego Section to succeed L. M. Limbach, who has left San Diego for a new position in Los Angeles.

4. Members of the **Southern California Section** were treated to a seminar on "Human Factors in the Satellite Vehicle" at the Dec. 5 meeting. The panel of experts comparing notes before the meeting include left to right: **J. C. Buckwalter,** vice-chairman of the Southern California Section; **Herman J. Schaefer, Ph.D.,** head of the Radio-Biology Department, Naval School of Aviation Medicine, Pensacola; **W. Vincent Blockley,** senior research engineer, physiologist, human factors, North American Aviation, Inc., Los Angeles; **Heinz Haber, Ph.D.,** chief science consultant, Walt Disney Productions; **John R. Poppen, M.D.,** consultant physiologist, Los Angeles; and **A. L. Klein, Ph.D.,** engineering design consultant, Douglas Aircraft Co., and professor of Aeronautics, California Institute of Technology.

Two New Air Springs Available for Buses

Based on paper by

A. B. HIRTREITER

The Goodyear Tire & Rubber Co., Inc.

DURING the past year, Goodyear has developed two types of air springs. One is a self-sealing spring of the bellows type, which employs the sealing principle used on tubeless tires. The other is a rolling sleeve or rolling lobe type.

Bellows Type Air Spring

The bellows type air spring is installed on two tapered end plugs without the use of bolts, nuts, clamps, or other retainers. It is built with integral bead and girdle rings to form a complete unit in itself. A small lip, similar to that used on passenger car tubeless tires, can be incorporated in the end plugs to assist the bellows in staying on their seats at excessive extensions.

If it is desired to remove axles, the air springs can be taken off quickly by exhausting air from the system and prying the bellows off their seats with a tire iron. The bellows are installed by putting them in place against the seats and turning on the air. They seal automatically. Bellows springs of this type require an expansion volume two or three times the bellows volume for relatively low frequency operation.

Rolling Sleeve Type Air Spring

The rolling sleeve type of air spring requires little or no expansion volume. Its characteristics are determined by the volume of the air in the spring, the shape of the piston, degree of outside support, and the volume of the expansion tank. A decreasing piston section from top to bottom is used to get very low frequencies. This results in a de-

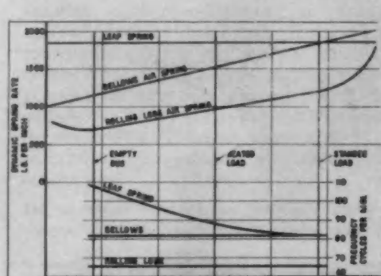


Fig. 1—Rear spring rate and frequency at various loads of a transit type bus leaf spring, bellows air spring, and rolling lobe air spring. The characteristics of air springs can be changed by using a lever ratio arrangement.

creasing effective area as compared with an increasing one which is common to all bellows type air springs. This is not a new concept but dates back to a patent of 1847.

With the rolling lobe type of air spring the rate characteristics are changed by varying the piston shape. The rate characteristics of the leaf spring, the bellows type, and rolling lobe type of air spring are compared in Fig. 1.

The Goodyear rolling lobe spring is self-contained and uses a formed piston but is without an external container. The construction is such that a fixed cylindrical outside diameter is maintained without any other constraining means. The advantages are simplicity, low cost, and extreme flexibility with very low natural frequency. The air requirements are very low because of the small expansion reservoir required. In some cases it is possible to eliminate the reservoir.

It is conceivable that the ultimate will be a power suspension of some type. Gas turbines or free piston engines will have excess power available for more accessories, such as a full power suspension which will maintain a bus parallel to and at a fixed distance from the mean road surface. Such a suspension will require a sensing device and a very fast working follow-up arrangement to maintain wheel contact with the ground and support the vehicle without changing its attitude so that passengers will not be subjected to any appreciable vertical accelerations. (Based on paper "A Resume of Bus Suspensions." It is available in full in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Paper Air Filters Show High Efficiency

Based on paper by

ROBERT J. LUNN
Donaldson Co., Inc.

THE average reported 25,000-mile operating life for a paper air filter on an on-highway truck is often credited to a self-cleaning action caused by vibration of the vehicle. It might better be attributed to the very little dust.

Paper filters are classed as expendable or replaceable, but they have to be strong and they are. They can be renewed by careful cleaning. Two methods are used for removing the dust layer to extend operating life. These methods and their results are shown comparatively in Fig. 1.

Curve A, shown on this graph, is the operating life of a new filter used as a primary. Curve B is a repeat test of

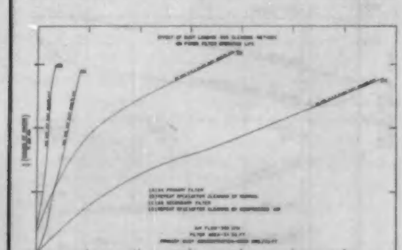


Fig. 1—Laboratory tests show effect of dust loading and cleaning methods on paper filter operating life. With proper cleaning, field life can be expected to increase by a factor of 5 or 10, depending on dust conditions.

this filter after cleaning by rapping, that is, by knocking against a solid surface to dislodge the collected dust. Note the increase in initial pressure drop, decrease in operating life, and increase in efficiency. This cycle can be repeated a number of times, but it must be remembered that the operating life has decreased below the original time of operation. Curve B will closely represent the repeat life if the degree of cleaning is maintained.

Curve C is the operating life of a new paper filter used as a secondary filter following an oil washed air cleaner. The increased operating life with reduced dust loading can be seen by comparison with Curve A. At the same time, the greatly increased specific resistance of the finer 0-5 micron dust as compared to that of the Air Cleaner Fine test dust is obvious from the relative weights of dust collected in each case. For the same pressure drop much less fine dust can be collected. However, the greatly reduced concentration permits a significant improvement in operating life of the filter.

Curve D is a repeat test of the Curve C filter after cleaning by compressed air. The increase in initial pressure drop, the reduced operating life and increase in efficiency observed with test B is also found in test D. Cleaning with compressed air is more effective for the finer dust condition than rapping. All of these data are obtained from laboratory tests. Field operating life will increase generally by a factor between 5 and 10, depending on actual dust conditions.

The efficiency data for the curves in Fig. 1 are for the paper filter based on total dust collected by the filter in each case. The filter efficiency for Curves C and D are less than that for A and B due to the finer dust handled by C and D. The overall efficiency of the air cleaner combination for Curves C and D was 99.98 and 99.99%, respectively. This may suggest that there is no important difference between an efficiency of 99.92% and one of 99.98%, but actually, with 99.98% efficiency the uncollected dust is reduced to one-fourth of that uncollected at 99.92% efficiency. Over a period of time, this small percentage difference can result in a significant accumulation of dust.

The efficiency of these paper filters is extremely high under the dust conditions present in engine air cleaning. However, performance characteristics other than efficiency are the ones of principal concern, and for that reason paper filters still must be considered experimental. (Based on paper "The New 3D in Engine Air Cleaners—Dry Design Developments." It is available in full in multilith form from SAE Special Publications Dept., 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Have Driver Report Trouble When It Starts

Based on paper by

THEODORE McGILL

Dept. of Sanitation, City of New York

SINCE most motor vehicle failures are progressive, many troubles leading eventually to breakdown can be discovered and reported by the driver.

Company and union policy varies with respect to a driver's responsibility for preventive maintenance. In nearly all cases, company policy does not permit drivers to make repairs. In many locations even minor repairs are forbidden by union contract. However, commercial fleet engineers and owners are in general agreement that a driver should understand the fundamentals of his vehicle's mechanical construction and operation, realize the importance and value of preventive maintenance, and assume certain simple duties essential to the effective functioning of a vehicle conserving program.

It is a driver's responsibility to drive in a manner to avoid vehicle abuse and so extend its life in terms of time and service. Usually, he is expected to note certain conditions before, during, and after operation and report them in accordance with set procedure. (Based on paper "The Engineer in Fleet Maintenance." It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Maintenance Simplicity Missing in Vehicle Design

Based on paper by

A. WALTER NEUMANN

The Willett Co.

MANY new features have contributed to the progress of the truck and the tractor but, in some cases, maintenance simplicity has been overlooked.

- One example of increased maintenance costs, due to design, occurs with a particular 5,000 lb truck when it is necessary to change the dual rear tires. The tolerances between the wheel and hub are so close that it requires the use of a 12 lb sledge in an awkward position under the truck to change a flat tire. This is not only time consuming and aggravating, but a definite waste of energy. In some cases, wheels have been ruined through this procedure.
- On one type of light-delivery truck it becomes necessary to jack-up the body, as well as the axle, in order to gain sufficient clearance around the rear fender to make an otherwise simple tire change.
- Wheel and rim widths have changed many times. In the past, we have had one tire size on as many as five different rim widths. Presently, we have three different rim widths for tires of several sizes. Since various types of wheels and many different rim widths present problems in providing spares for large fleets, uniformity and standardization would certainly be conducive to reduced maintenance costs.
- The exhaust tail pipe on a certain make of tractor is pointed towards the left rear wheel causing the fumes to strike the braking mechanism. Since the exhaust fumes are often moisture-laden, this sometimes causes the braking mechanism to freeze-up.

To remove and replace the power-steering-pump belt on some model vehicles it is first necessary to remove the lower radiator hose and all that entails, which is especially troublesome

when antifreeze is used.

- The windshield-wiper motor on one model tractor is very difficult to service in that it necessitates the removal of the dash panel. Possibly a simple plate of some sort could be provided on the outside of the cab which would permit servicing of this motor.
- Much time could be saved in replacing the door glass in one make of heavy-duty tractor if the door were slotted at the bottom permitting the glass to drop through. This operation, which now requires almost one hour, could then be performed in just a few minutes.

(Based on paper "Design and Its Effect on the Maintenance of Trucks and Tractors." It is available in full in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Tests Prove Bearing Wear Can Be Predicted

Based on paper by

M. W. SAVAGE
and
L. O. BOWMAN
California Research Corp.

RADIOACTIVE tracer tests of bearing rubbing wear confirm predictions made from calculations based on the theory of bearing load carrying capacity. The theory states that load carrying capacity is a function of the rate of change of bearing load position as well as the rate of journal rotation, bearing and journal dimensions, oil viscosity, and minimum oil film thickness to prevent wear.

In the conduct of these tests an irradiated bearing was installed on a connecting rod journal near the center of a multi-cylinder engine. A middle journal was used to reduce radiation hazard to the front and rear of the engine. The wear particles from the bearing accumulated in the lubricating oil which was circulated by the transfer pump through the counting circuit. The radioactivity level was counted and recorded by a Geiger tube, counting ratemeter, and recorder. Lead shielding is placed between the counting chamber and the test bearing (approximately 15 ft apart) to insure a low background radiation level at the counting chamber.

Findings of the test may be summarized as follows:

1. Connecting rod bearing wear of babbitt-surfaced bearings can be determined rapidly by using a radioactive tracer technique.
2. Relative connecting rod bearing wear at different operating conditions can be predicted by using the load

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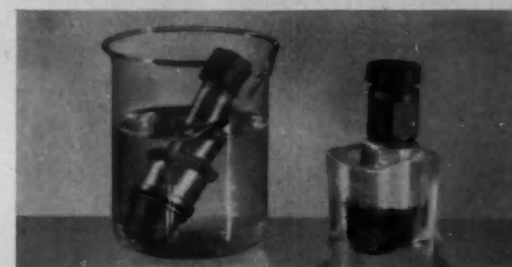

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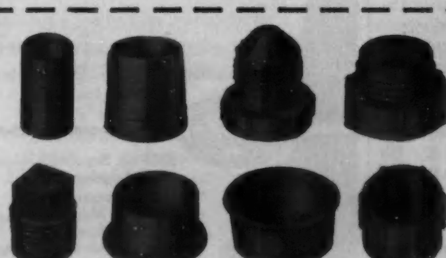

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carrying capacity concept.

3. Bearing wear is a function of the magnitude and source of the maximum bearing load.

4. The most severe bearing wear occurred during engine starts or at extreme high speed operation.

5. Bearing wear is lower with an SAE 30 grade oil than with an SAE 10W grade and still lower with an SAE 10W-30 oil.

(Based on paper "Radioactive Tracer Measurements of Engine Bearing Wear." It is available in full multilith form from SAE Special Publications Department, 485 Lexington Avenue, New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Accessory Systems Will Need Redesigning

Based on paper by

RALPH E. MIDDLETON
Lockheed Aircraft Corp.

TOMORROW's aircraft will have to operate with hydraulic and pneumatic system temperatures ranging from 400 to 600 F, or even higher. This poses problems in the selection of materials and detail design of components amounting to a revolution in the art of accessory design. It also creates problems in the design of the system itself.

When available organic fluids are used at such temperatures, the hydraulic system must be airless, in the sense that the fluid in the reservoir must be separated from the air which is introduced by the changes in volume that occur during operation and by the means used to pressurize the reservoir. Air in intimate contact with the fluid causes the latter to break down at high temperatures. Separating the fluid from the air raises the new problem of bleeding the system of air, since it is no longer possible to allow the air distributed throughout the system to collect in the reservoir, to go out through a vent. It must now be possible to regulate the intake of fluid, while bleeding, and simultaneously to regulate the amount of fluid admitted (corresponding to the level of fluid admitted to the ordinary reservoir).

The difficulty of finding a fluid that will remain stable at high temperatures, work satisfactorily at low temperatures, have good lubricity for pumps and actuators, and work well with seals, tempts turning to the fluid most readily available—air. Air has the advantage of being stable within the temperature ranges under consideration, has extremely low inertia and, of course, low weight, will not burn and can be used to store large amounts of potential energy that can be released extremely rapidly. But with these advantages comes a number of problems. First there is the problem of getting

an adequate supply of air. If the services to be performed require a considerable amount of continuously-supplied energy, the power to compress to the high compression ratios necessary gets out of step in weight and space. The interstage cooling required, poses a heavy load on an already overloaded cooling system.

The problem of sealing high pressure air is even more mountainous than the problem of sealing fluid, particularly since sealing is also needed at low temperatures.

The difficulties with lubricity for moving surfaces under high loads at high speeds and high temperatures experienced with hydraulic equipment are suffered equally with pneumatic equipment. In some respects the situation is worse with pneumatic equipment because lubricant is not supplied automatically where it is needed. It becomes necessary to consider all forms of dry lubricant as well as other schemes for lubricating highly loaded parts. (Based on paper "Hydraulic and Pneumatic Problems in High Performance Aircraft." It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members, 60¢ to nonmembers.)

Electronic Tooling Will Aid Small Manufacturer

Based on report by

H. C. MORSE
Ford Motor Co.

A SMALL job shop can't justify the extent of automation that a larger company can. Therefore, electronically controlled machine tools are often a major aid in establishing a competitive method of machining.

Electronic control of tools is defined as "the operation of machine tools from stored information other than templates."

The development of tools requires the "team approach." Such a team should consist of a process engineer, a tool engineer, a plant layout engineer, a materials handling engineer, a plant engineer, and an industrial engineer. This team, with one man as coordinator, designs tooling with technical consideration for loading, locating, clamping, disposing of chips or offal, and unloading, as well as the actual processing operations. Tool cost and manufacturing cost are also important considerations.

There is a trend toward the design of tools with the building block concept. This consists primarily of a base composed of details assembled from the off-the-shelf clamps, locations, support plungers, etc. Thought should be given to the basic design of the tool to allow handling various sizes of similar parts at the start of the tooling program.

(This article is based on the secretary's report of the panel on Tools, Dies, Jigs, and Fixtures presented at the SAE Tractor Production Forum, Milwaukee, Sept. 1956. Panel leader was W. R. Catey, Aircraft Engine Division of the Ford Motor Company. Panel secretary was H. C. Morse of the same company. Panel members included: B. W. Bacon, Ford Tractor Plant; M. N. Nelson, International Harvester Co.; W. E. Brainard, Kearney and Trecker Corp.; H. V. Schwalenberg, North American Aviation, Inc.; and Harvey Prill, Wisconsin Motor Corp. This report together with 8 other panel reports are available as SP-316 from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: $1.50 to members; $3.00 to nonmembers.)

Designing Turbo-Pumps For Better Performance

Based on paper by

J. E. BORETZ

Stratos Division, Fairchild Engine and Airplane Corp.

ANALYSES of turbine and pump combinations for handling fluids in turbine or rocket engines leads to the conclusion that:

1. The take-off weight of rockets and missiles is directly affected by turbo-pump overall efficiency and required suction specific speed.
2. The arrangement of components of a turbo-pump unit depends to a great extent upon the application, the fluids being pumped, and the nature of the turbine driving fluid.
3. Turbine selection is governed by weight and efficiency considerations. Velocity ratio and overspeed and control requirements influence the detailed design of a particular turbine type.
4. The use of the aerodynamic theory and cascade data in turbine design provides a more rational understanding of fluid flow and may permit the extension of turbine operation to include boundary layer control.
5. Aircraft turbo-pumps are capable of operation at much higher suction specific speeds due to their shorter operating life and in many cases the nature of the fluid pumped.
6. The use of cavitating axial inducers to provide sufficient pressure rises at the pump inlet to permit overall pump operation at minimum net positive suction head is a currently applied technique in aircraft turbo-pump design. An extension of this technique to include boundary layer control through the use of slots and flaps may produce the next step forward in the attainment of even higher suction specific speeds. (Based on paper "High Speed Turbo-Pumps." It is available in full in multilith form from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Ideal Load Distribution Increases Truck Payload

Based on paper by

M. C. HORINE

Mack Manufacturing Corp.

LOAD distribution is of two sorts:

1. That having to do with the placing of the various items which make up the payload at the loading platform or en route, and
2. That which results from the location of axles, bogies, tandems, and fifth wheels in relation to distances between axles and centers of gravity.

Of the two kinds, the first, which we may call the **loading distribution**, is solely the responsibility of the operating personnel. There is little the manufacturer of the vehicle can do about it. The second, which we may call **geometrical load distribution**, is the joint responsibility of the purchaser and the producer. The better the geometrical load distribution, the easier it will be for the operator to achieve the most favorable loading distribution.

Though we cannot hope for perfection, the closer we can come to ideal load distribution, to utilizing the legitimate capacity of each axle in the combination, the greater the payload we can carry—and without overloading of any kind.

In the case of loads of uniform density, such as liquids, identical packages, or bulk materials such as crushed

XIX

This is the nineteenth of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

Determining the Proper Depth of Case in Alloy Steels

In the previous article of this series we discussed the carburizing of alloy steels, pointing out that the purpose of carburizing is to provide a hard, abrasion-resistant outer shell or "case." Such a discussion naturally gives rise to the question, What factors influence the choice of case? Should it be shallow? Medium? Deep or extra-deep?

While it is not always wise to formulate hard-and-fast rules, the following may be used as a general yardstick:

Shallow cases (less than 0.02 in.). Suitable where wear-resistance alone is the chief requirement, and where good surface condition after heat-treating is advantageous. Not suitable if high stresses are apt to be encountered in service.

Medium cases (0.02 to 0.04 in.). For high wear-resistance. Will stand up under substantial service loads and stresses. The thickness is sufficient to permit certain finishing operations, such as light grinding.

Medium-to-deep cases (0.04 to 0.06 in.). For high wear-resistance. A case in this depth range is essential where continuing friction is involved, especially friction of an abrasive or semi-abrasive nature. It is also a good precautionary measure where application of the finished part may sometimes involve crushing action.

Extra-deep cases (more than 0.06 in.). Cases of this depth can be obtained by extending the furnace time in pack carburizing. Highly wear-resistant, they also withstand shock and impact. A large camshaft of an internal-combustion engine is a good example of a part requiring the extra-deep case. This is of course particularly true of the cam lobes themselves.

If you require specific advice concerning case-hardened parts, by all means communicate with our Metallurgical Division. Bethlehem technicians are always on call, and you can depend on their recommendations. And you can depend on Bethlehem, too, when seeking new supplies of alloy steels; for Bethlehem makes the full range of AISI standard grades, as well as special-analysis steels and all carbon grades.

If you would like reprints of this series of advertisements from No. I through No. XVI please write to us, addressing your request to Publications Dept., Bethlehem Steel Company, Bethlehem, Pa. The first 16 subjects in the series are now available in a handy 32-page booklet, and we shall be glad to send you a free copy.

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BETHLEHEM STEEL

stone or coal, correct loading distribution is almost automatic, so that the best geometrical distribution is of supreme importance.

Loads of unequal density, such as miscellaneous dry freight, machinery, or a mixture of full and empty containers, are more dependent upon loading distribution. With such loads, it is often possible to compensate, to some extent, for unfavorable geometrical distribution. For example, if a tractor-semitrailer combination has such faulty geometrical distribution that an undue proportion of the weight is thrown on the tractor rear axle, the loaders may place the load in such a way that the heavier items are located more toward the rear.

But the task of the loaders is much easier when the geometrical distribution favors even loading distribution.

(Paper "More Payload Through Better Weight Distribution" was presented at the Salt Lake Group and SAE National Transportation Meeting.)

Prompt Repair Reduces Tubeless Tire Troubles

Based on paper by

R. R. ROBSON
The Firestone Tire & Rubber Co.

PUNCTURED tubeless truck tires should be repaired without delay in a manner to keep air from seeping into the body of the tire.

Tubeless tires will run for several thousand miles after puncture by nails, but it is not good practice to permit it. Air entering through the punctured area is likely to lead to trouble in the tire body or to difficulty after the tire is recapped. If punctures are detected and repaired quickly, the chances of later trouble can be very largely eliminated.

We recommend a permanent type repair with a positive bond to seal the air whenever there is a break in the air retaining innerliner of the tube. If, for example, a nail has entered the tire, it should be removed at the earliest opportunity and the hole filled with a vulcanizing type of gum. A permanent repair should be placed on the inside of the tire.

Other people believe a plug inserted from the outside effects a permanent and satisfactory seal. In our experience, this is a proper temporary expedient, but one which allows air to get into the tire around the plug, possibly causing separation. We believe some kind of self-vulcanizing plug may be developed for this purpose, but until it appears, we regard the exterior repair as temporary. (Based on paper "Truck Tire Trends." It is available in full in multilith form from SAE Special Publications, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Poses New Technique For Environmental Test

Based on paper by

G. L. GETLINE

Convair Division, General Dynamics Corp.

ENVIRONMENTAL vibration test procedures for propeller driven aircraft cannot be applied to turbojet aircraft, so a procedure is proposed which bases on the use of electromagnetic shaker equipment in conjunction with magnetic tape recording techniques to provide a vibration and noise analogue of an aircraft.

The electromagnetic shaker is nothing more than a loudspeaker (without cone) which will respond to a complex stimulus. The stimulus will be provided by a magnetic tape and the arrangement is identical in principle to tape recorder and playback systems currently marketed.

Two Basic Problems

The proposed system has two basic problems requiring study. They are:

1. Generation of the test tape.
2. Accurate reproduction by the shaker of the test tape input.

The primary problem is the generation of a test tape which will provide an environmental vibration analogue to an airplane and also be suitable for accelerated testing procedures. It is proposed to handle this as follows:

Environmental vibration data will be obtained in an airplane under typical operating conditions, using suitable types of transducers mounted on primary airframe (or engine) structure at points of inherent rigidity. The outputs of these transducers will be recorded on magnetic tape which will be cut and spliced into closed loops, each loop corresponding to a particular test condition. Each loop will then be played back into an electronic wave analyzer coupled to a plotting system which will provide direct continuous graphs of vibratory amplitude, or any other desired variable, as a function of frequency. The vibratory responses consist essentially of a modified "white" base on which are superimposed the magnified responses due to structural resonances. A set of these graphs, covering all test conditions, will be obtained for each transducer installed in the test plane.

The next step is to separate the data into groups corresponding to dynamically compatible areas of the airplane. The curves from all transducers in each area will then be superimposed and an envelope established over the maximum "white base" level. Also, the frequencies of all significant resonant peaks will be properly located. The amplitudes of the peaks will be established by the maximum amplitude of the envelope; the peaks could be ap-

proximately in the form of triangles with the widths equal to one-half the base widths on the actual response peaks. The resultant graphs represent the generalized vibration environments of each particular dynamical area of the airplane and the curves will be the basis for the generation of the test magnetic tapes.

To generate electrical signals which will correspond to the generalized vibration environment, a "white noise" generator may be used in conjunction with suitable filters. The electrical output of the generator will be modified by an equalization circuit, e.g. notch filters, so that it will approximate the environmental curve. The modified output will then be impressed on magnetic tape. The final step will be to impress the resonant peaks on the same tape by using high and low (band) pass, sharp cut-off filters on the output of the "white noise" generator.

The test magnetic tape can be used with any electromagnetic shaker equipment which operates from an electronic supply. It is simply used to provide the electric signals for the shaker amplifier. However, the shaker system must have a flat response as a function of frequency with the test item attached. This can be done by equalization circuits for the shaker-amplifier system.

The tape analogue can be used to simulate actual environmental conditions or exaggerated conditions for accelerated test. Control is had by adjusting the output of the shaker-amplifier by means of an attenuator. During a quality control test the attenuator would be adjusted to make the shaker output level correspond to the nominal airplane response level. This might be called a reference level of 1.0. During a qualification test, where it is desired to simulate a large number of hours of service by a test of a few hours, the attenuator might be adjusted to make the shaker output level two or three times the normal airplane response level. This would be called a reference level of 2.0 or 3.0 as the case might be. Appropriate playback levels could be established for various classes of components and types of tests.

At Convair, where we are concerned with the particular problems of the F-102 series all-weather interceptor, we have found that a multiplying factor of 2 is conservative when we attempt to qualify a component for 1000 hr of service by means of a 10-hr test. Under these circumstances, the component must be functioning during these tests and its function must be completely and continuously monitored. (Based on paper "A Look at the Concept of Vibration and Noise Environmental Testing." It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Tests Axle Gears In Four-Square Machine

Based on paper by

GEORGE L. ROTHROCK
Cadillac Division, General Motors Corp.

A NEW dynamometer test machine of the four-square type is being used by Cadillac for the testing of axle gears in a normal environment. Fig. 1 shows the complete machine with control panel.

Two standard type axle housings are integral parts of the machine. A removable inspection plate is provided on the top of the housing to permit inspection of the gear during test. The differential and carrier assemblies to be tested are assembled to the housings.

The axle shafts are connected by universal joint shafts to four large Falk right angle bevel gear boxes located at the four corners of the machine. These boxes are connected, in turn, by universal joint shafts. The axle drive pinions are connected by a central V-belt pulley by short universal joint shafts. With all shafts connected, torque induced in any shaft is transmitted through all the gears and shafts in the system. A small initial torque load is applied by use of a spanner wrench on the companion flanges located adjacent to the V-belt pulley.

The torque reaction of the axle drive gears is taken through the axle housing. One of the housings is mounted so that it is free to rotate on grease lubricated journal bearings. Two air cylinders attached to the housing through lever arms are arranged to supply a couple to rotate the housing and, hence, resist the torque reaction.

Air pressure applied to the cylinders is regulated to provide the desired torque load and to maintain it at the desired level. The machine is driven by a 30 hp reversible motor which supplies ample power to overcome the frictional power losses in the machine. The axle is cooled by flowing water over the carrier casting. The rate of water flow is regulated to control the temperature of the lubricant to 185-195 F.

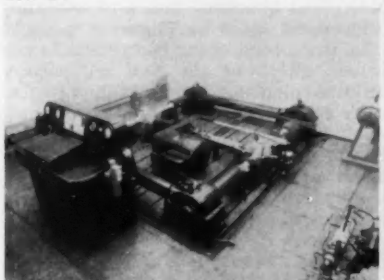

Fig. 1—This dynamometer test machine represents the latest in a series of axle gear test rigs used by Cadillac over the past 30 years.

In terms of car operating conditions, the dynamometer test load of 400 ft lb and speed of 2500 rpm corresponds approximately to maximum engine torque multiplied by 1.45, at a speed of 43 mph, with a 3.36 to 1 ratio axle gear. (Based on paper "Dynamometer Testing of Gears in a Normal Environment." It is available in full, in multilith form, from SAE Special Publications Dept., 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Efficiency Features New Type Air Cleaners

Based on paper by

B. GRATZ BROWN
Dexter Eng. Div., Fram Corp.

THE modern pleated paper air cleaners used in many current passenger cars combine high efficiency with easy replacement of the cleaning element in

a shape suitable for low-hood cars.

The paper area for a given size of engine must be large enough to hold a reasonable amount of dirt before the restriction increase is significant. Pleating the paper enables this large area to be fitted into a small space. After pleating to the proper depth with sharp folds, the resin impregnated paper is heat cured. The cured resin preserves the sharp folds, imparts physical strength and helps to maintain the pleat spacing during assembly. Water repellency is given the paper by treatment with silicone compounds.

The pleats of paper are held between two screens for stability and protection. The outer screen is made of perforated metal, coarse-meshed so as not to plug up before the paper has been used effectively. The inner screen is of 16 mesh to act as a flame arrester if the engine backfires.

The ends of the pleated paper are held in plastisol. This is poured into a mold as a liquid to fuse into solid form by heat, leaving a recess between inner and outer screen. The plastisol at the end of the screens is sufficiently soft and strong to serve as a gasket to seal the element in the air cleaner housing or silencer, thus providing a new gasket every time the element is replaced. When the element is serviced, the plastisol ends permit the paper to be flexed to loosen the dirt.

The pleated paper type of air cleaner is easily cleaned by rapping it on a flat surface or by blowing it out backwards gently with air. Washing is not recommended because it removes the silicone compounds and will cause ultimate disintegration of the paper. Under most conditions, cleaning can be performed many times before replacement with a new element is needed.

Pleated paper air cleaners range in efficiency from 98 to 100% and they maintain this efficiency at all air flows from the highest to the lowest. (Paper "New Developments in Carburetor Air Cleaners" was presented at SAE Houston Section, September, 1956. It is available from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Electronic Weighing Aid to Proper Loading

Based on paper by

RICHARD HORNIDGE

Baldwin-Lima-Hamilton

A TYPICAL electronic weighing system has three basic components. The first is a load-sensing device usually called a transducer or load cell. Its function is to provide an electric signal proportional to changes in load. An elementary system has one load cell, but larger and more complex systems may have several.

The second component is the structure which carries the load. It can be a small platform or a storage tank. Restraining members which hold this structure in position must allow it to move a few thousandths of an inch in a vertical direction, and any restraint they exert must be linear in nature. The third component is an instrument which interprets the load cell output in convenient units such as pounds. A wide range of instruments is available, including the dial type indicator, instruments which indicate in digital form and printers.

The transducer can operate on a number of different principles, including variable inductance, variable capacitance, vibration of a tuned wire in a magnetic field, and variable resistance. The variable resistance types further divide into the potentiometer and resistive strain gage types, and the

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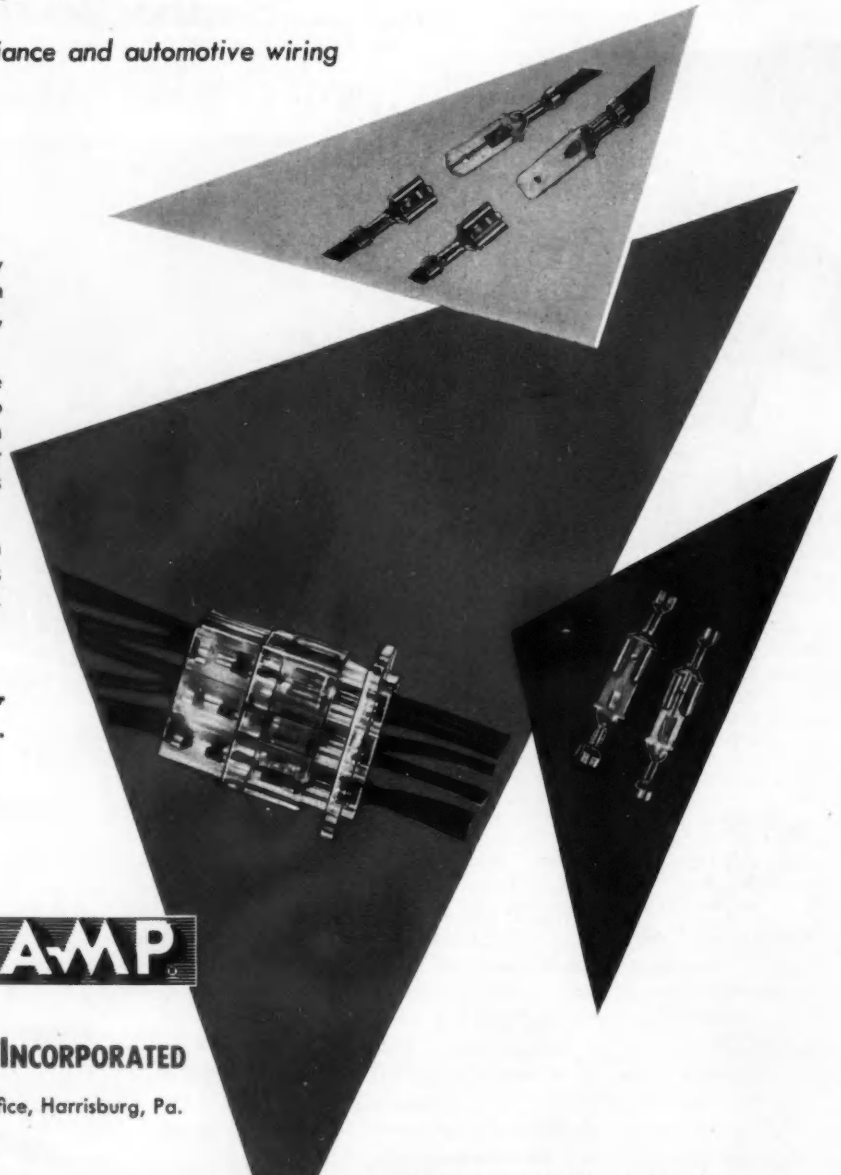

A new highly versatile assembly unit that makes one operation out of many. Saves time, trouble, money.

Simplifies such operations as the connecting of wall switches to built-in ranges . . . top with bottom circuits in clothes washer . . . front and back assemblies to car electrical systems.

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latter can be subdivided further into bonded and unbonded strain-gage transducers.

Systems which use the bonded strain gage type of load cell maintain a high degree of accuracy because there are no moving parts, other than the slight movement of the column, hence nothing to wear out. The load cells are hermetically sealed which permits the unit to be used in areas containing fumes, moisture, and abrasive dust. A 10,000 lb unit in a trailer scale is very compact, measuring only 3-½ in. in diameter and 6-½ in. in height. (Based on paper "Electronic Weighing." It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Vapor Lock Problem Needs Further Studies

Based on paper by

D. P. BARNARD, V

R. B. FELL

E. H. SCOTT

The Standard Oil Co. (Ohio)

and

G. WAY

Ethyl Corp.

A VAPOR lock test procedure mutually acceptable to the automotive and petroleum industries is a prime need. The procedure should bear some relationship to field conditions and, in its simplest form, should incorporate a simple rating system having some relationship to a reference fuel system. This would aid in cross communications and would remove some of the mystery attached to vapor lock expression.

There is also need for an industry-wide, vapor handling, parking lot survey. This would parallel the octane requirement survey now being carried out. Such a survey should include the effect of air-conditioner installations.

Total car population could be plotted as percent of cars satisfied with any vapor-to-liquid ratio at a given reference temperature. Hitherto, surveys of this type have covered only a very small portion of the total car population.

An examination of the effects of cooling system and fuel pump deterioration on fuel handling severity would be of great value. Some recent surveys have indicated that the fuel is not necessarily the prime contributor to vapor lock. On the other hand, almost all limited studies are carried out on late model cars tuned to manufacturers' standards. This begs the question "What portion of the total car population does the sample represent, and should the fuel supplier carry the burden of protecting deteriorating systems?" (Paper "Weather or Lock Vapor Lock Study, Road and Laboratory" was presented at SAE National Fuels and Lubricants Meeting, November 1956. It is available in full, in multilith form, from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to memb~~e~~rs; 60¢ to nonmembers.)

Atomic Energy Pays Off in Industry

Based on paper by

DONALD G. STURGES

The Carborundum Co

RADIOISOTOPES are widely used for accurately measuring and controlling the thickness of glass, metals, paper, plastics, rubber, certain coatings, textiles, abrasive cloth and paper,

and linoleum. This application alone has saved millions of dollars by reducing substandard production and associated scrap. More than 200 such applications are in existence.

The radiographic inspection of welds and dense metal bodies is another highly important application. It has grown rapidly because of the great variety of radioisotopes of differing characteristics readily available. The correction of bad welds in high pressure piping the elimination of internally defective driveshafts and pump casings, and the rejection of faulty castings before expensive machining, are some of the benefits. More than 200 firms perform radiographic inspection with radioactive materials other than radium, several firms rendering a custom service which swells the actual number of users.

Another ingenious application is the identification of petroleum products being transported in multiple purpose pipelines. The separation is done effectively and cheaply by adding a small amount of radioactive material at the loading end of the pipeline at the time of changeover of product fed to the line. When this radioactive tracer reaches the receiving point, its radiation is picked up by suitable instrumentation and a sharp cut-off made between the two products. One such pipeline using this technique runs for more than 650 miles and carries at least four different products.

Isotopes are facilitating the study of the mechanism of wear in engines and bearings, cutting tools, gears, and electrical contacts. They make it possible to detect very small amounts of wear and to determine the mechanism by which different lubricants control wear and the effects of varying speeds, bearing pressures, and temperatures on wear. These and other related observations will result in machines of improved design, better efficiency, longer life, and lower cost.

Use of radioisotopes is estimated to save $100,000,000 annually in the United States alone. Yet we are only on the threshold of industrial utilization.

Massive radiation exposure is being tried in the sterilization and preservation of foods and drugs and has great promise. Many serious problems remain to be overcome before the practice can be put into everyday use, but these are being attacked vigorously.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

What's he doing?

This is one of our field engineers, at work on a precision bearing installation for an experimental engine in a customer's plant.

He's one of the bearing experts from Cleveland Graphite Bronze, world's leading maker of sleeve-type bearings and bushings. Backing up on-the-spot field engineers like him is an advanced team of bearing design men, and a forward-thinking staff of scientists and technicians at the Clevite Research Center. After the engineering problems are solved, your orders are filled accurately and quickly by an up-to-the-minute, well distributed group of manufacturing units.

If you want this team working on your problems too, we'd be glad to hear from you.

CLEVITE CORPORATION

Cleveland Graphite Bronze Co.
Division of Clevite Corporation
CLEVELAND 10, OHIO

CHICAGO DETROIT LOS ANGELES NEW YORK

Evaluates Laboratory Fatigue Test of Gears

Based on paper by

JOHN A. HALGREN

and

D. J. WULPI

International Harvester Co.

LABORATORY testing of gears has been stimulated by the disadvantages of field testing. The latter is so time consuming, expensive and laden with variables that inadequate sampling or testing can easily lead to difficulties later in service performance and with competitive product cost.

Laboratory methods for testing spur gears include chassis dynamometer standard dynamometer, opposed tractor, opposed transmission, modified four-square and single tooth bending fatigue tests. None of these exactly duplicates service conditions or field testing. Each represents a compromise which must be considered in analyzing results. Each has its own, set of variables, some of which are common to service variables and to other testing methods, and some which are peculiar to itself.

Possibility for Greater Control

One great advantage of laboratory methods is the possibility it gives for greater control over test conditions. Test speeds, test loads, lubrication and many other variables can be held within close limits. Automatic controls and safety devices often can be incorporated in the test machines to allow tests to be made with a minimum of labor and maximum utilization of the 24 hours in a day.

Chassis dynamometer testing most closely resembles field testing in the physical sense because the complete product is used, including the source of power. Large power absorbing equipment is required which introduces mass-elastic problems into the test. In certain instances, such as shock loading, simulation of important service conditions has been proved evidently by experience, but reproducibility is not too good. The testing method suffers from limitations in maximum load which can be applied to a gear without shock loading. Also, it measures the strength of only the weakest link in the complete product. In general, it is slow and expensive.

Standard dynamometer testing rigs also require large power sources and power absorbing devices, both of which are expensive and introduce their own mass-elastic problems. Excellent accuracy in test loaas and test speeds is possible. Overloads can be applied within the dynamometer's capacity. Only the weakest member in the gearbox is tested.

Opposed transmission testing rigs

and opposed tractor testing rigs use the same locked-in torque principle which characterizes modified four-square gear testing machines. The gear is tested as an assembly, just as in dynamometer tests, and failure occurs at the weakest member, which may or may not be the one to be evaluated in a gear development program.

Single tooth fatigue testing is used to measure the bending strength of gear teeth. One tooth at a time is tested in the manner of a cantilever beam. By successive testing, the strength of many teeth of the same gear may be tested and endurance limits obtained.

Two types of test fixtures are possible: the gear tooth may be loaded directly or, the gear tooth may resist a torsional load applied to a shaft. Either type can be used with a variety of load-exciting machines.

Simple test fixtures and clear results are the primary advantages in this type of test. More specifically, the advantages are:

1. Elimination of test machine variables. Wear or failure of parts of rotating gear tests frequently confuse results.

2. Elimination of gear variables. The effect of pitch line runout, tooth spacing, and involute profile errors are eliminated since contact is made in the same position at all times.

3. Equipment is simple. Since machines usually have automatic cutoffs, the tests can be run continuously with the machine stopping upon tooth failure. For spur gears the fixtures are uncomplicated and easily dismantled for changing the test gear.

4. Permits measurement of bending stress. If the gear teeth are large enough, it is relatively easy to measure bending stresses in the root fillet when the test is operating.

5. Elimination of progressive surface damage due to pitting, wear, or scuffing, since no relative motion occurs against the tooth. Only bending fatigue failures occur.

The single tooth test has its disadvantages. These are:

1. Limits failures to bending.

2. Lacks direct correlation with operation. In rotating service gear teeth are not loaded individually. Usually at least one and a half teeth are in contact at an average time. The tangential load carried by the tooth may be obtained from the test, then calculations must be made in terms of the contact ratio to determine the torque this would represent in service.

3. Special fixturing may be required for each design tested.

Tests show that it is possible to determine clearly the effect of various metallurgical factors upon the bending fatigue strength of gear teeth. (Based on paper "Laboratory Fatigue Testing of Gears." Complete paper is available from SAE Special Publications Department, 485 Lexington Ave., New York 17, N. Y. Price: 35¢ to members; 60¢ to nonmembers.)

Based on Discussion

B. W. Kelley, Caterpillar Tractor Co.

The effect of frictional force between the loading device and the tooth being loaded arises as a problem with single tooth testing. The tooth and rim or web of the gear will deflect considerably as the load is applied. If the hub of the gear is fixed rigidly or not free to move, a frictional force will be exerted toward the root of the tooth, reducing the maximum fillet stress. This reduction may be as high as 15% because of a high static coefficient of friction in the contact area.

All of our gears in this type of test machine are mounted on shafts encased in rubber bushings, allowing the entire gear to move laterally as the tooth deflects downward. The movement is visually significant. The necessity for this movement also explains why the speed of loading should be kept down, particularly for heavier gears.

New Members Qualified

These applicants qualified for admission to the Society between December 10, 1956 and January 10, 1957. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Atlanta Section

Leon E. Baughman (M), John H. Eaton (J), William D. Sheppard (J).

Baltimore Section

Richard J. Kenny (J).

British Columbia Section

Henry C. Givins (M).

Buffalo Section

Robert K. Hathaway (J).

Canadian Section

William Vernon Andrews (J), John G. Dunbar (J), Melville A. Phipps (M), Greig B. Smith (A), John K. Woodburn (J).

Central Illinois Section

Sami Akman (J), Arthur O. Beer (J), Henry Dean Bordeaux (M), Edwin J. Eckert (J), Jack L. Langenberg (M), Alfred W. Newton (M), Lester Painter (M), Ray L. Schrader (M), John Robert Williams (J).

Chicago Section

Donald B. Bickler (J), Milton R. Liechty (M), Edward J. Marcinski (M), William A. Mulcahy (A), Paul Andre Myers (J), Bert M. Walter (A).

Cincinnati Section

Lawrence Bruce Venable (M).

Cleveland Section

Paul E. Grevstad (J), Capt. Benjamin T. Hill, Jr. (M), Richard L. McGee (J), H. Allen Nitshke (M), Andrew C. Palguta (A), James John Poledna (J), Chester H. Powers (M), Jack A. Suddreth (J).

Colorado Group

Arthur L. Haubert (A), Floyd P. Mercure (A).

Dayton Section

1st Lt. Louis L. Levy (J), Walter F. Prien, Jr. (J).

New Members Qualified

Continued

Detroit Section

Duane S. Anderson (J), Ned A. Bania (A), Vaughn F. Bossow (J), Kenneth E. Brooker (M), Willson P. Brumback, Jr. (J), William Raymond Carey (J), V. E. Clark (M), C. Richard Clauson (M), Dale Kenneth Cole (J), John B. Colletti (J), Gene O. Cowie (J), Robert A. Doerr (M), R. C. Frevik (M), Raymond Leonard Gee (J), Russell F. Gee (J), Edward J. Heitzman (J), Howard E. Hermenau (A), William C. Hester (J), Charles N. Hughes (J), Eugene Jankus (J), John L. King (M), Anthony Krenzer (A), Gordon G. Krey (J), H. J. LaDouceur, Jr. (A), Durward Decker Leeper, Jr. (J), George W. Leineke (M), Bud E. Lowe (J), James Lunan (M), William Margolin (M), Joseph H. McIntyre (M), Donald E. Meyer (J), William J. Molnar (M), W. J. Moriarty (A), Werner Munz (J), Claude A. Patalidis (M), Peter N. Pentescu (J), Max L. Romisch (M), Robert J. Rumpf (M), Corado R. Salet (M), R. E. Sawyer (A), Harold A. Schmidt (J), Robert C. Shaffer (M), Frank S. Spedding (J), David A. Stromquist (J), Roger T. Struck (J), Joseph V. Svatora (J), Waino J. Tervo (J), Wesley D. Tomlinson, Jr. (J), Wayne D. Warner (J), Leo E. Warren (J), H. Eugene Weiss (J), B. T. Wykoff, Jr. (J).

Hawaii Section

Yoshiaki Tanaka (A).

Indiana Section

Charles E. Bowling (J), Joseph E. Kachnik (M), Max L. Moser (J).

Kansas City Section

Gerald G. Abbey (J).

Metropolitan Section

Eugene M. Beattie (M), Frank X. Burke (A), Steve Edward Colucci (J), Francis J. Curran (J), E. Boykin Hartley (A), Mark Lewis Hessel (J), David G. Kempner (A), Martin Miller (J), Edward G. Myers (J), James F. Ray (J), Raymond J. Rogers (J), Alfred W. Siman (M), John F. Stark (J), Hans U. von Borcke (A), Lee Ronald Webster (J).

Mid-Continent Section

Richard W. Hurn (M).

Mid-Michigan Section

Joseph P. Casassa (J), John H. Christ (J), Carlen Edmund Larson (J).

Milwaukee Section

Royal F. Bandemor (A), Urban T. Kuechle (A), John Peter Wahlman (J).

Mohawk-Hudson Section

James O. Blanton (M), Joseph J. Waldron (A).

New England Section

Robert B. Clark (M), Lawrence V. Mason (J), Philip C. Wolff (A).

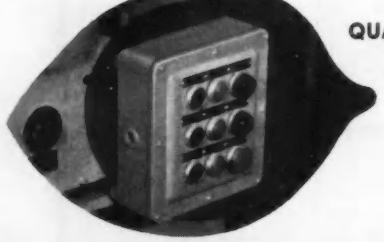
Northern California Section

Joseph A. Aguilar (J), Roland M. Andersen (M), David Roy Stevenson (J).

Northwest Section

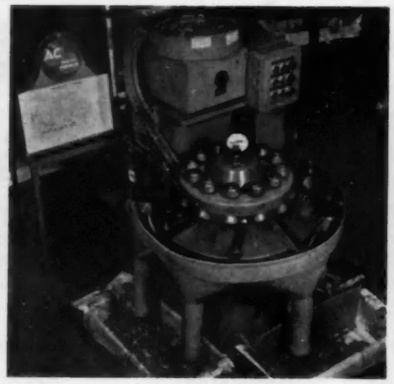
John G. Harrison (J), John E. Isakson (J), Roy H. Johanson (A), John J. Lermusik (J).

The "eagle eye" department...

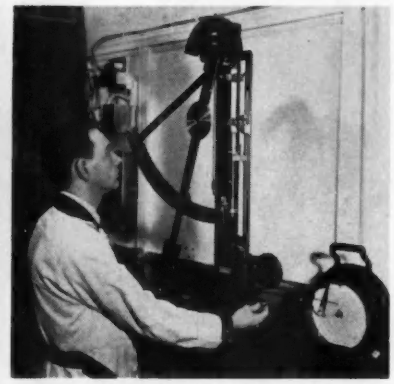


QUALITY CONTROL: One department is responsible for the quality in every one of AC's Quality Products. Here is a step-by-step story behind the quality control of one AC product — the fuel pump. The fuel pump is used as an example because it is the heart of a car's engine and literally millions of drivers unknowingly rely upon this device for dependable transportation.

PARTS INSPECTION — Quality control begins with a rigid inspection of representative groups of component parts. Careful screening at this point reduces later rejection of completed assemblies to a minimum.

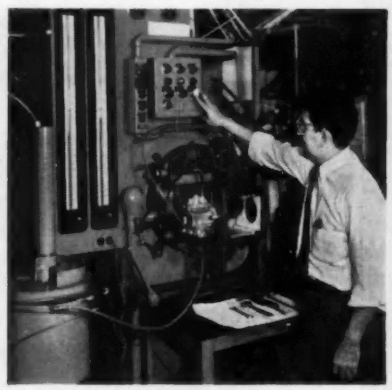


VALVE SORTING — Valve-sorting machine gives pressure check to 100% of all valves used in AC Fuel Pumps. Valves are accepted or rejected automatically . . . and graded within narrow limits, thus eliminating human error.

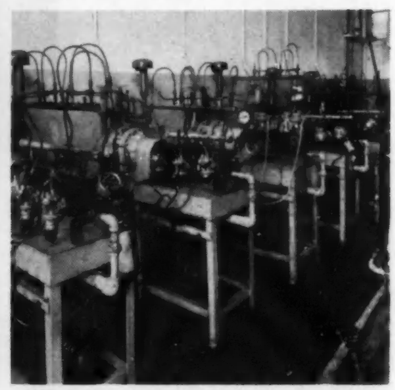


LABORATORY — The AC research laboratory maintains a constant watch over critical diaphragm materials, checking thread count, tensile strength, weight, sizing, moisture, pressure, flexing and solubility for each roll of cloth.

FINAL TEST STAND — 100% of fuel pump production goes through the final test stand where each pump is thoroughly checked for prime and pressure under conditions comparable to actual engine operations.



FUNCTIONAL TEST STAND — This is the ultimate check . . . used for all first-run pumps and for complete analysis wherever indicated. Prime, pressure and capacity for both liquid and vacuum are carefully analysed.



LIFE TEST — Random samples are withdrawn from production and run under carefully controlled laboratory conditions until breakdown occurs as a final check on quality, performance and life of the product.

RESULT: AC's unique record of millions upon millions of trouble-free fuel pumps is in itself testimony to the effectiveness of AC's inspection and quality control. What is true of fuel pumps is also true of other quality products produced by AC. Specify them . . . ask for them. Their uniform high quality and remarkable dependability will make you glad you did.

AC

AC SPARK PLUG THE ELECTRONICS DIVISION OF GENERAL MOTORS

FLINT — 1300 North Dort Highway • **CHICAGO** — Insurance Center Building • **DETROIT** — General Motors Building

QUALITY PRODUCTS

New Members Qualified

Continued

Oregon Section

Donel R. Olson (J).

Philadelphia Section

Robert H. Butler (M), John Joseph Spicer, Jr. (M).

St. Louis Section

Lynn Mark Norton (A), George W. Stearns (J), Kenneth Wm. Tobin (J).

Salt Lake Group

George Ralph Cravens (J).

San Diego Section

Garland O. Goodwin (J).

Southern California Section

Earl J. Beck, Jr. (M), Francis L. Bertolino (J), Fred L. Boeke (M), Norris Walton Clarke (J), Bill L. Coffey (J), Robert W. Graves (M), Elpidio Igne (J), Kenneth M. Jones (J), John E. McKune (J), J. H. Miner (A), David W. Moore (J), Nyle O. Movick (M), David L. Olle (J), Robert J. Robinson (J), Charles Stanley Ross (A), Philip H. Steward (J), William H. Theis, Jr. (J), A. V. Walker (M).

Southern New England Section

W. Robert Spencer (M), John Robert Stevenson (J).

Syracuse Section

Alexander H. Dunbar (M).

Twin City Section

Derek D. Legg (J).

Western Michigan Section

J. C. Owen (M).

Wichita Section

S. S. McDonald, Jr. (A).

Outside Section Territory

Robert C. Butler (J), Joseph W. Davis (M), Thomas P. Gilchrist (J), Chedo P. Graham (M), Leo C. Peters (J), Wilbur W. West (M).

Foreign

Egon Ardelius (M), Sweden; Frank William Baggett (M), England; R. Baratan (A), India; Birger Holmer (M), Sweden; Yoshito Matsuo (M), Japan.

Applications Received

The applications for membership received between December 10, 1956 and January 10, 1957 are listed below.

Alberta Group

Henry W. Higgins.

Baltimore Section

Robert S. Dowdy, Tibor F. Nagey, Emerson K. Patten.

British Columbia Section

John Kerr, Jake John Martens, Ed Moore, C. G. A. Roach, Marvin Wilson.

Buffalo Section

Harold T. Dow, Jr., Edward W. Friend.

Canadian Section

Harry John Graham, Thomas Melville Mayberry.

Central Illinois Section

Neil D. Bearsley, Carl W. Hanzi, Gary H. Kling, Donald G. Zook.

Chicago Section

Louis E. Benton, Bruno Biava, Charles Lewis Brand, Austin M. Breining, David John Bundy, Nick E. DeLuca, Jr., Edward H. Fisher, Roger S. Hutton, Cesareo Lopez, Donald W. Moyer, Robert A. Nejdl, Myron E. Pugh, Svend Erik Tengbom, Theodore O. Wagner.

Cincinnati Section

Cecil J. Goldthorpe, Ernest J. Haas.

Cleveland Section

Lester G. Beltz, George S. Holzheimer, Richard B. Twickler, Daniel R. Wessman, Albert P. Wuchter.

Dayton Section

John F. Pribonic, William P. Stewart, Jr., William Dean Walther.

Detroit Section

Marion H. Antonini, John Louis Bigus, Ralph C. Bolz, Edward K. Bowen, Murray Burnstine, James Vincent Chabot, James Edward Cousins, Leon L. Dodge, Eugene Richard Dziadon, Sedgwick S. Field, Albert G. Hodgson, Eugene H. Jary, Varton Arshag Karagosian, William J. Kelly, Stanley William King, Albert M. Lane, Martin L. Lerner, Auguste Francois Moiroux, Harland W. Oates, Willard L. Pearce, Donald R. Pringle, Freddie D. Randall, Daniel W. Roper, James A. Royer, John W. Rosenkrands, Peter Henry Sayer, Rex Warden Sprowls, Roy Stott, Jr., Hollis P. Zimmerman, Jr.

Hawaii Section

Stephen Richard Benchwick.

Indiana Section

Donald E. Chalfant, James Clayton Norris, J. M. Selzer, Jr., Stanley H. Updike, Max E. Walters, Ralph H. Warkentin.

Kansas City Section

Benjamin W. Bogdan, Robert G. Glenn, Willard C. Hargiss

Metropolitan Section

Ferguson J. Byars, Wallace Chinitz, Robert E. Cohen, Arch L. Herron, William P. Johnson, Herbert G. Schultz, Edwin C. Younghouse.

Mid-Continent Section

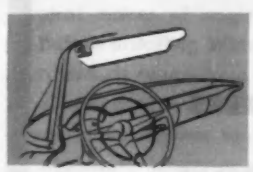
Jack W. Foster, Jr., George S. McDonald, Jr.

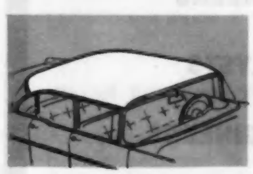
Mid-Michigan Section

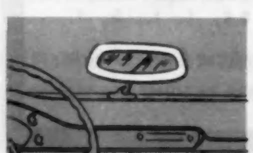
Clifford G. Studaker.

Impact Absorbed... Life Saved

by URETHANE FOAMS!







Urethane foams made from National Nacconates* can be life-savers! Controlled resilience makes urethanes ideal for safety-padding that absorbs shock with a minimum of dangerous rebound.

And because they are economical, urethanes will be used generously for maximum protection on instrument panels, sun visors, rearview mirrors, headliners and rear of forward seats. As a low-cost extra, headlining can be extended to provide welcome insulation against sun and cold.

Urethanes are easy to fabricate. They can be foamed in place quickly or pre-molded to required shapes. Sheets can be cut and sewn or tacked. And urethanes can be foamed directly to outer coverings in a simple operation for snug fit.

Other important features: Urethanes resist vermin, moisture and chemicals and are flame-retardant.

For additional information regarding this versatile material, write National Aniline today. Your letter will bring prompt response.

NATIONAL ANILINE DIVISION

ALLIED CHEMICAL & DYE CORPORATION

40 Rector St., New York 6, N. Y.

Akron Atlanta Boston Charlotte Chattanooga Chicago Columbus, Ga. Greensboro Los Angeles New Orleans Philadelphia Portland, Ore. Providence Richmond San Francisco Toronto

Allied Chemical

*Trademark name for National Aniline's Diisocyanates

Applications Received

Continued

Milwaukee Section

John D. Behnke, Robert P. Daykin, Donald Walter Dei, J. F. Gettrust, Larry E. Higgins, Clemens A. Johnson, Lawrence C. Oertle, Sr., Roger W. Page, Richard M. Reisel, Bernard M. Silverberg, Donald H. Stevens.

Montreal Section

Andre Guimond, Kenneth C. Rackham, R. M. Smith.

New England Section

Bernard B. Becker, Richard C. Sedlak, Houston F. Tyner.

Northern California Section

Eugene C. Jacobson, Ralph W. Leininger, Hans E. Menter, C. C. Mugford, Robert E. Nicholson, James Fred Richards, William A. Selby.

Philadelphia Section

George J. Balling, David Seeley Blew, III, Joseph A. Ewing, Morris D. Gottesman, George L. Houghton, George B. Myrtetus, James F. Stevenson, Robert M. Wells, Jr.

San Diego Section

Ellis L. Helvenston, Bernard J. Simons, Vernon E. Wolcott.

Southern California Section

Bernard J. Barbeito, Charles E. Barnes, William Carroll, Jose de Kastro, Arthur E. George, Robert J. Gottlieb, Louis Stanley McBride, Francis C. Morris, Raymond E. Nemec, John Taylor Wilson.

Southern New England Section

Anthony J. Bosco, G. Renfrew Brighton, Malcolm A. Buell.

Syracuse Section

Zelmar Barson.

Texas Section

Roy H. Coleman, Martin J. Mulroy.

Western Michigan Section

Royce G. Engel, Jr., Nelson T. Levings, Jr., James C. Pearl.

Williamsport Group

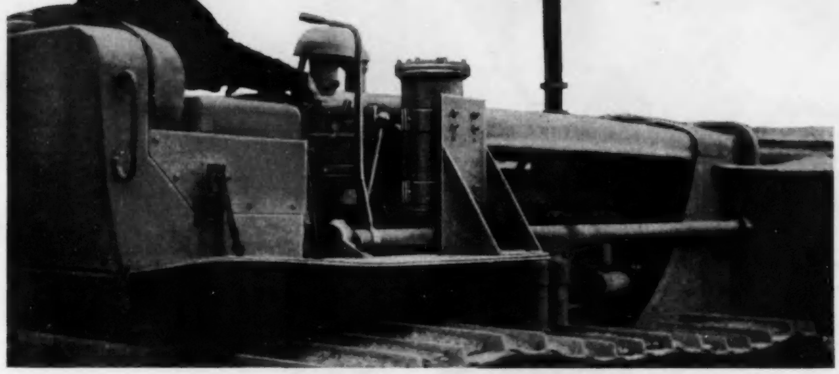
Edwin James Ounsted.

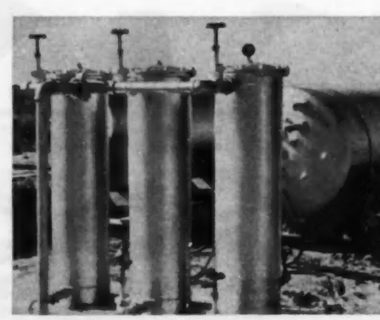
Outside of Section Territory

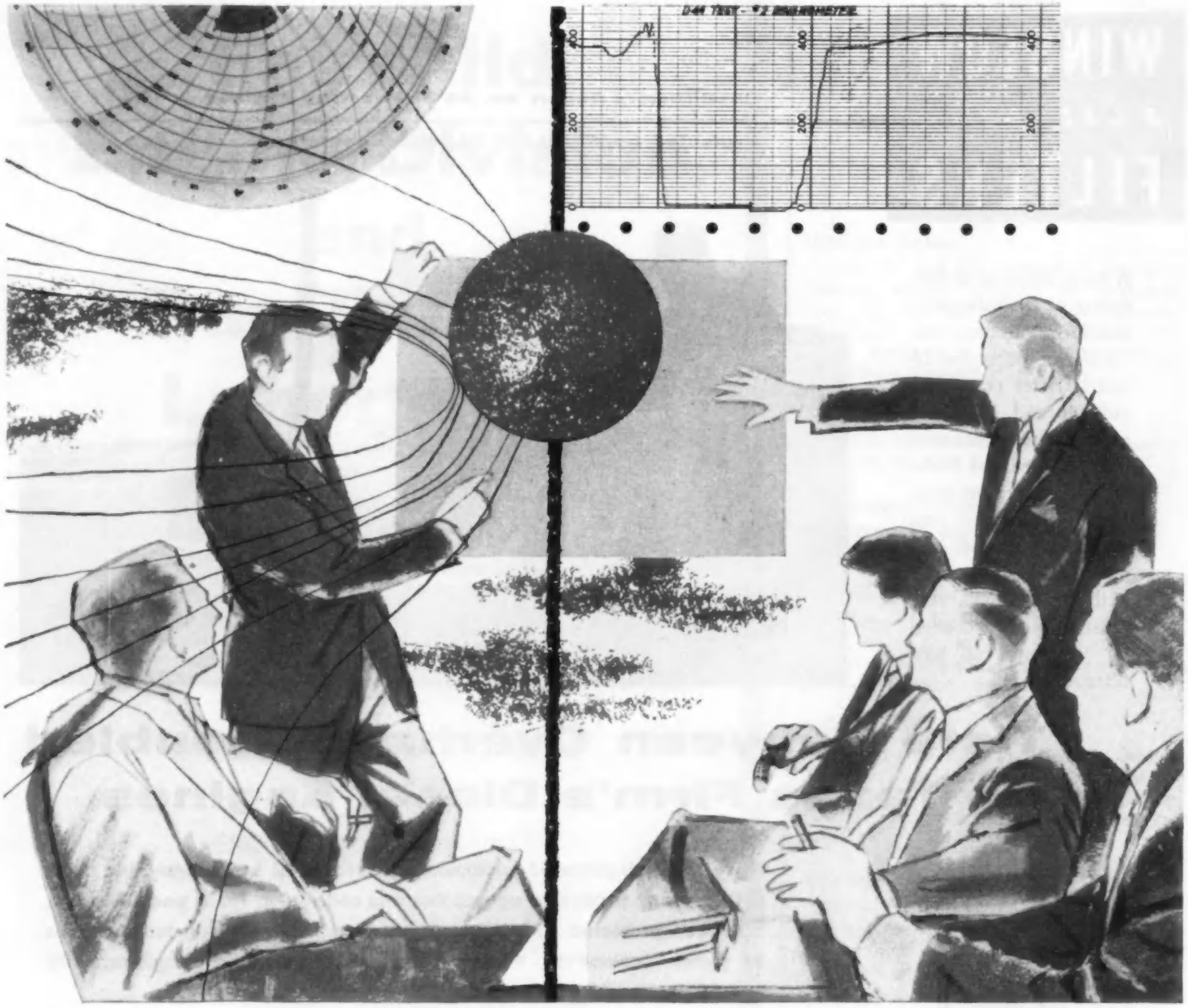
Harry A. Bancroft, Everett H. Lee, J. W. Looney, Harold K. Smith, William L. Smith, Nealy Homer White.

Foreign

Herman Kramer, Netherlands.







Your Vehicle!

Choose the proven weight-saving combination of New TDA® *Tandem Driving and Trailer Axles!*

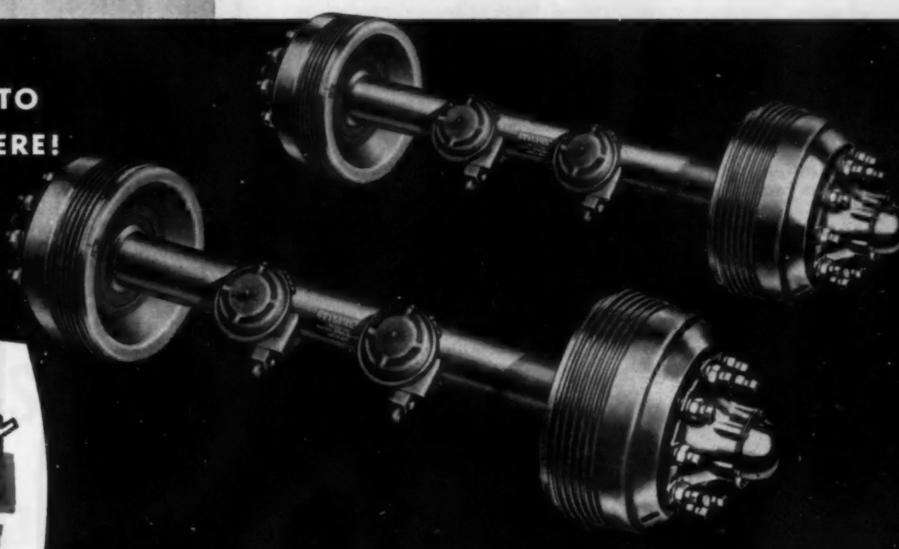
Used together, Timken-Detroit® lightweight tandem driving and trailer axles weigh almost ½ ton less than other axle combinations of the same capacity. This means up to *980 extra pounds* of bonus payload every trip.*

TDA Axles are the choice of America's leading truck manufacturers. For complete information, contact your original equipment dealer, vehicle dealer or branch today!

**Where 36,000 lb. tandem axle loading is permissible.*

SAVE UP TO 280 LBS. HERE!

TDA TK-500 Series Trailer Axles



Up to 110 more gallons of milk per load!

Up to 21 more cases of can goods per load!

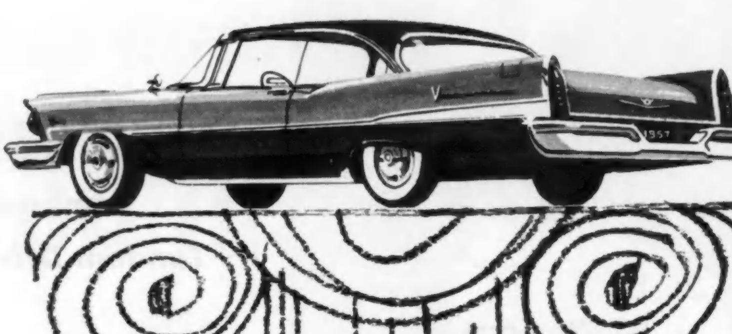
Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York
Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

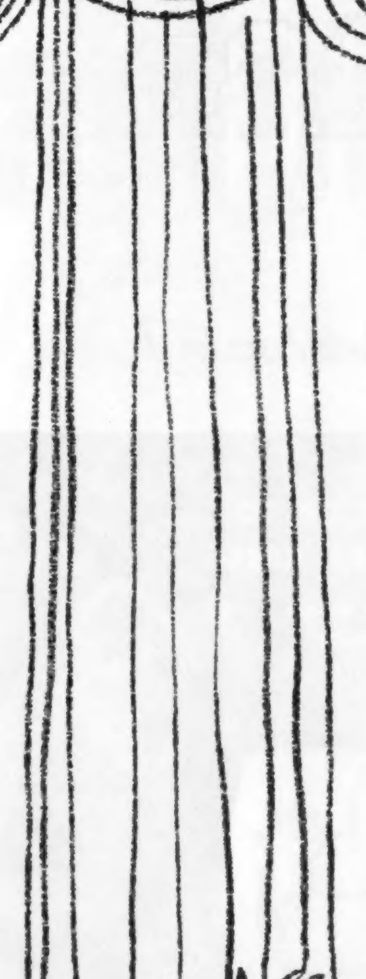
TIMKEN Detroit AXLES

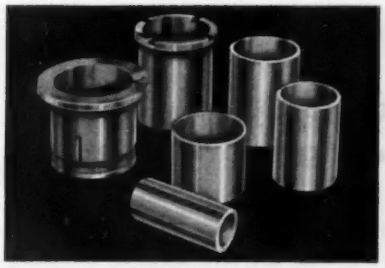
TIMKEN-DETROIT AXLE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
DETROIT 32, MICHIGAN

The Accepted TDA Standard
TRADE MARK REGISTERED

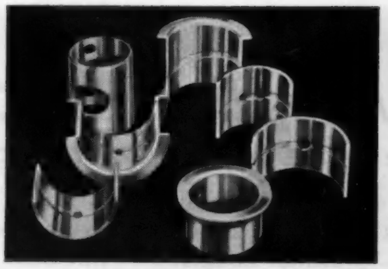
WORLD'S LARGEST MANUFACTURER OF AXLES FOR TRUCKS, BUSSES AND TRAILERS



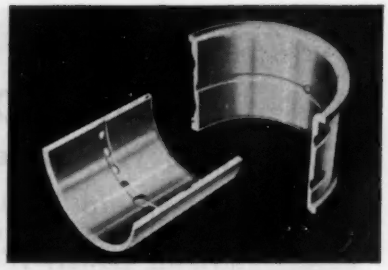




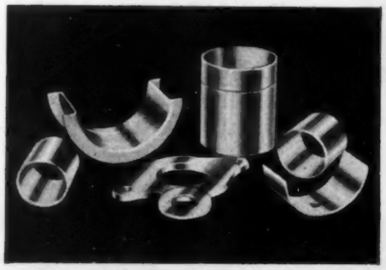
CAST BRONZE



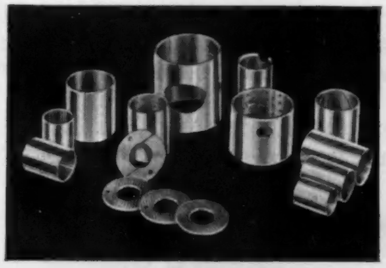
BABBITT AND STEEL



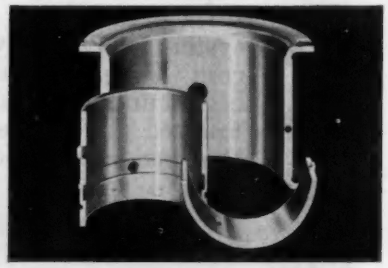
BABBITT AND BRONZE



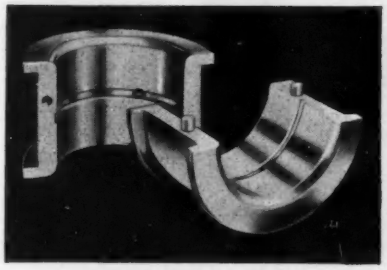
BRONZE OR COPPER-LEAD ON STEEL



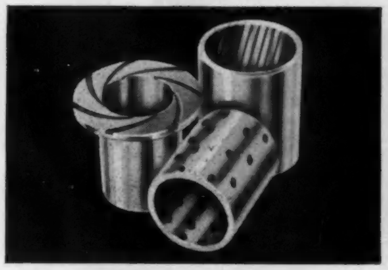
ROLLED BRONZE



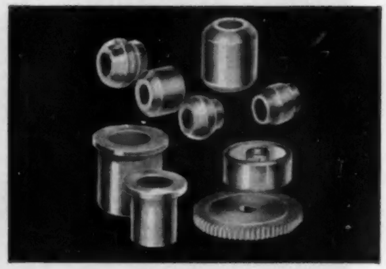
ALUMINUM ON STEEL



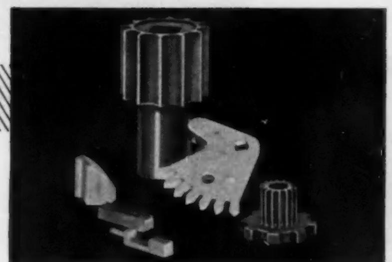
CAST ALUMINUM ALLOY



GRAPHITED BRONZE



LEDALOYL SELF-LUBRICATING



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If Sleeve Bearings are your problem...

Johnson Bronze can provide the solution. We produce all types of sleeve bearings in a number of standard sizes. In addition, we have the facilities to produce an infinite variety of custom-made bearings to your specifications. The best bearing for any application can be found among the types illustrated above. To get the exact bearing you need at reasonable cost, contact Johnson Bronze Company, 675 S. Mill Street, New Castle, Pa.

JOHNSON Bearings

From conception to catapult...

this missile was guided by design engineers

Due aboard Fleet surface and submarine units soon is a new package of striking power. It's Chance Vought's supersonic Regulus II surface-to-surface missile, a complete weapons system and an advanced attack concept. Vought engineers not only conceived and designed this missile—they tailored it for Fleet operation. And they achieved unique success largely because it was a job they knew from experience. For 11 years they've had pilotless weapons on the board, in the shop, or in the air. Their Regulus I ship-to-shore missile has been a standard Fleet weapon for two years—on station, ready to go. Against this background, Vought's missile design team appears just as significant as the weapon it developed.

5 IMMEDIATE OPENINGS FOR DESIGN ENGINEERS

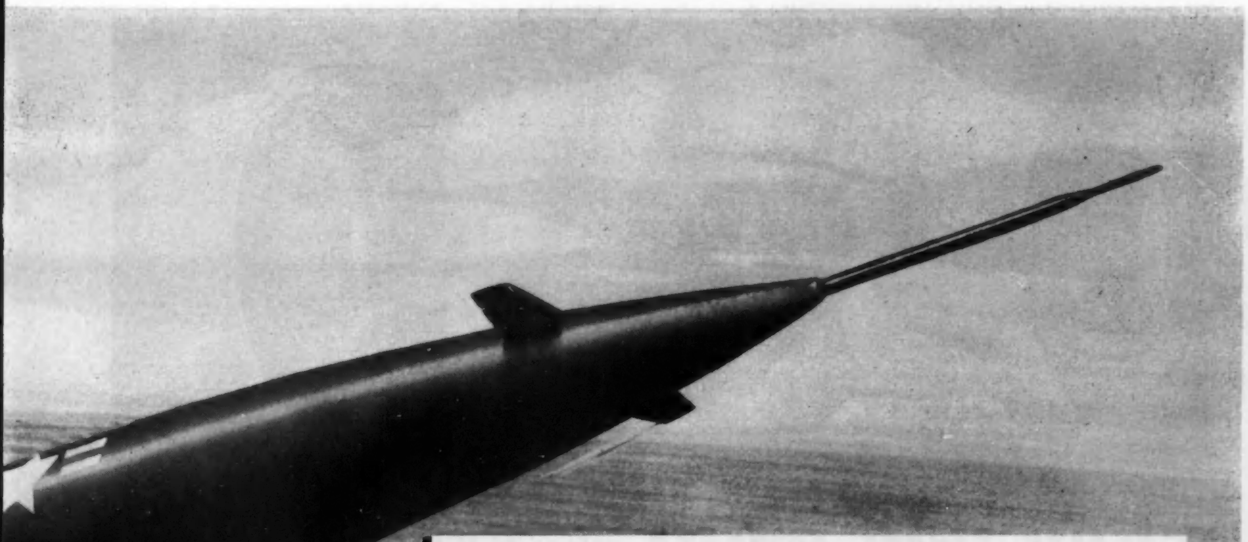
Senior missile airframe designer. To develop, design and test missile structural members, including control surfaces and linkages. Degree, or equivalent, with at least three years mechanical structural design experience.

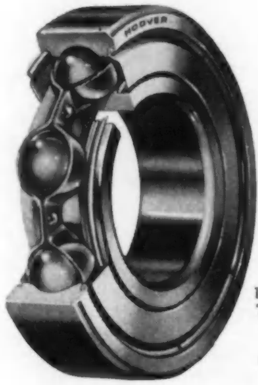
Cockpit designer and stylist. To specialize in functional, attractive cockpit design. Requires at least two years experience in industrial styling plus two years practical design experience and strong creative ability.

Designer for missile and piloted aircraft ground-handling equipment. To develop ground-handling tools ranging from special wrenches to engine-change dollies. Offers opportunity for first-hand observation of Fleet operations. Requires engineer with flair for mechanical design, degree or equivalent experience.

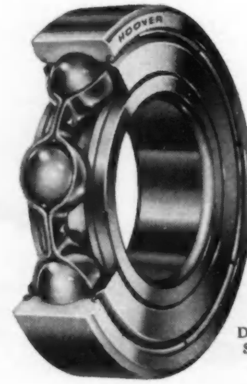
Electronics designer for missile and piloted aircraft check-out equipment. Desire designer with E.E. degree or equivalent, plus three to five years electrical or electronic design experience.

Design specialist in problems of ground-level escape. Desire engineer with at least three years concentration on pilot escape mechanisms, plus two to three years practical design experience.

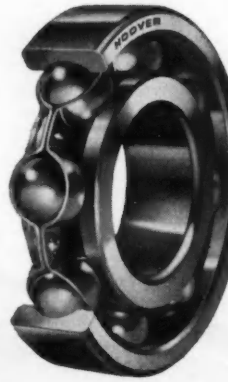




DOUBLE SEAL—
Teflon contact seal shown. Available with snap ring and with single or double seal.

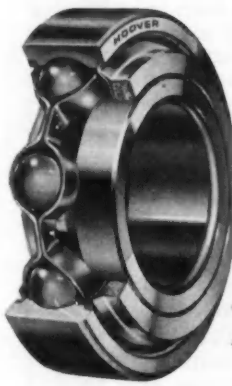


DOUBLE SHIELD—
Same sizes available with single shield.

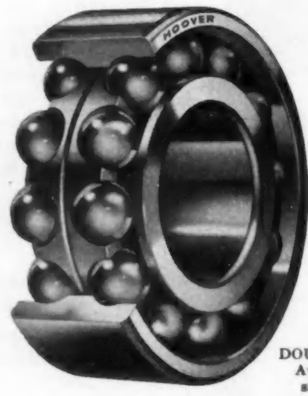


SINGLE ROW RADIAL—
Also available with snap ring.

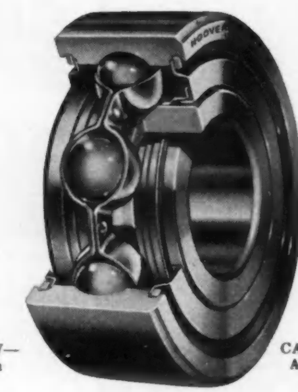
when you want quality



COMBINATION FELT SEAL AND SHIELD—
Either standard or wide outer ring.



DOUBLE ROW—
Available with single shield.



CARTRIDGE—
Available with snap ring.

you want hoover

When you want *quality* bearings to add to the performance, long life and smooth operation of your products, you want Hoover Ball Bearings.

Hoover Ball Bearings combine the exactness of *Micro-Velvet* Lapped Balls with the smoothness of *Hoover Honed* Raceways. The result . . . top quality bearings that assure unexcelled performance —quietness—long life—and heavy load capacity.

Investigate Hoover's line of ball bearings in the light, medium and heavy series. Their microscopic precision adds up to your best buy in ball bearings. Manufacturers are invited to call in Hoover engineers for technical assistance. Write for information.

Micro-Velvet and *Hoover Honed* are Hoover Trademarks.

HOOVER BALL AND BEARING COMPANY, ANN ARBOR, MICHIGAN

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- ☐ Bearings with Shields
- ☐ Bearings with Seals
- ☐ Combination Shield and Seal
- ☐ Cartridge Bearings
- ☐ Double Row Bearings

Hoover Ball and Bearing Company, Ann Arbor, Mich.
Please send information checked. Mail copy of "Hoover Handi-Book of Anti-Friction Bearings."

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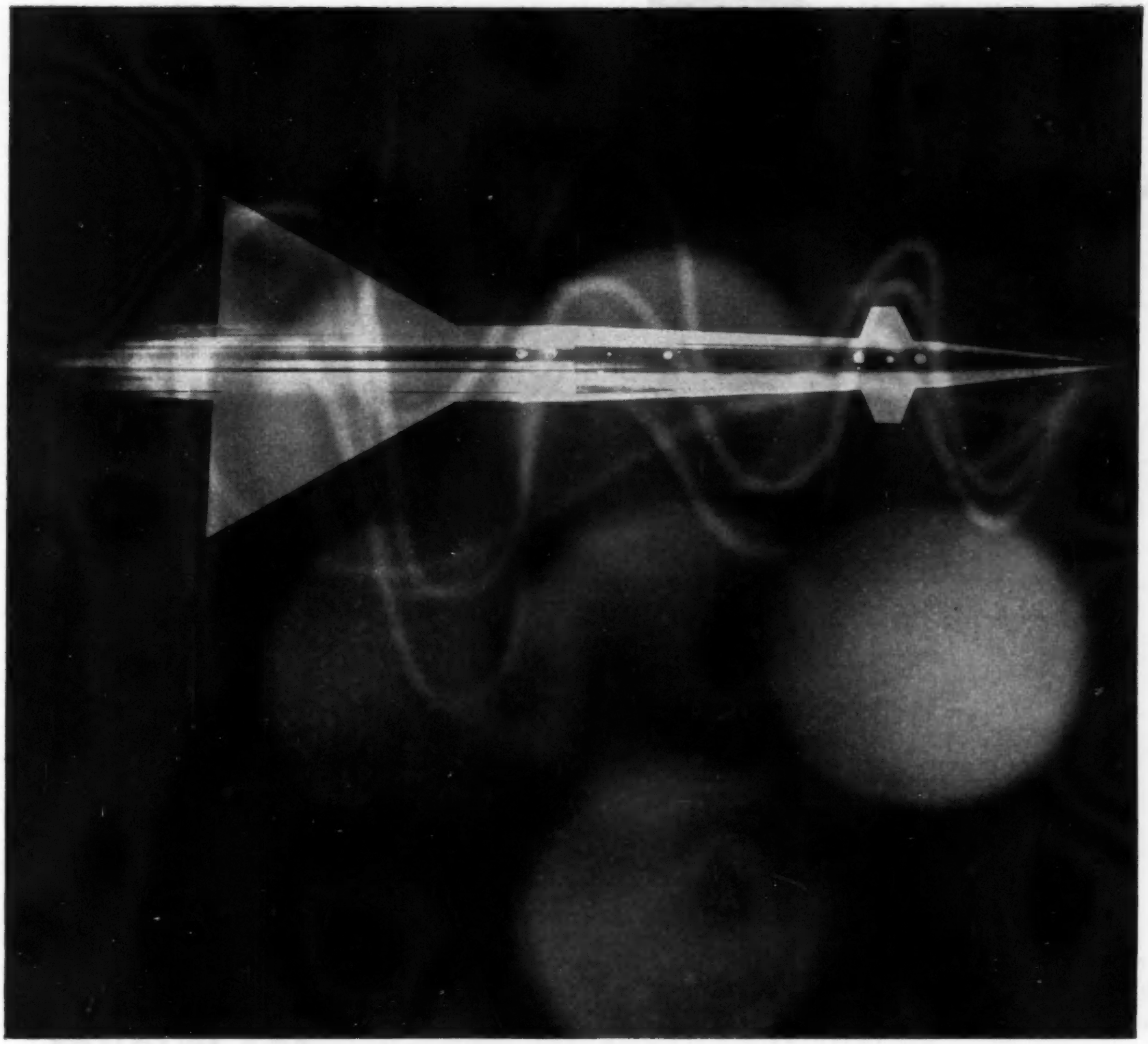
Title________________

Company________________

Address________________

City________ State________

10



Portrait of a man's supersonic alter ego

The speeds and altitudes achieved by today's aircraft have placed them beyond a human pilot's physical resources. They fly faster than he can think, decide and react... exert forces beyond his own strength or that of old-time hydraulic systems.

The answer: electro-mechanical colleagues with the superhuman reflexes, sensitivity and strength to cope with the phenomena of supersonic flight.

At AUTONETICS, Automatic Pilots are being designed and produced that will control a vehicle during its mission, referenced by input signals from the Pilot, Autonavigation Equipment, and Fire Control Systems. These Autopilots are able to control a vehicle throughout an extreme flight regime more precisely and swiftly than the human pilot.

In addition AUTONETICS has developed an Automatic flare computer integrated with the Autopilot for fully automatic or semi-automatic landings in manned or unmanned vehicles. In the case of manned vehicles, flare signals are provided to the pilot through the ILS indicator. The flare computer thus adds all-weather capabilities to any vehicle by providing a controlled flight path to touchdown under the most adverse weather conditions.

AUTONETICS is a quality and quantity producer of flight control, autonavigation, armament control, computer and other complete control systems with significant implications for commerce and industry.

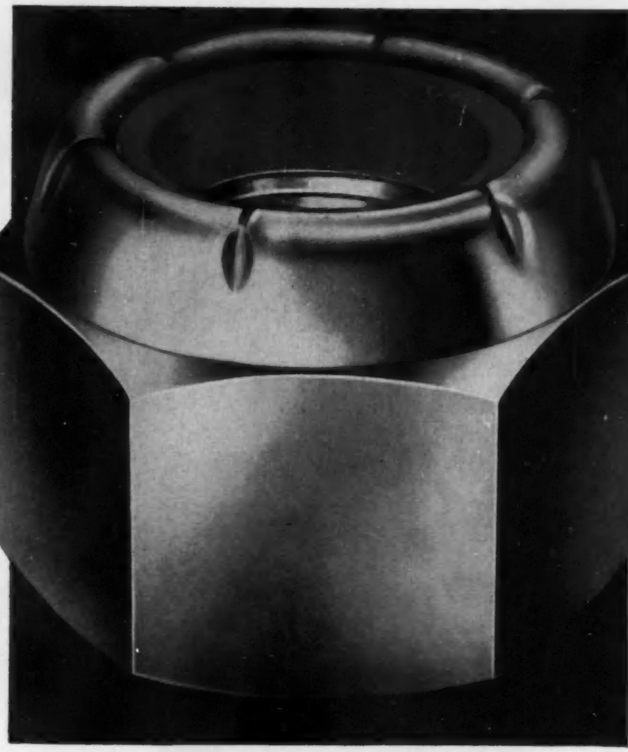
For more information—or for employment in this dynamic field—write: AUTONETICS, Dept. SAE-71, 12214 Lakewood Blvd., Downey, California.

Autonetics

A DIVISION OF NORTH AMERICAN AVIATION, INC.

AUTOMATIC CONTROLS MAN HAS NEVER BUILT BEFORE

What's special about this STOP NUT?

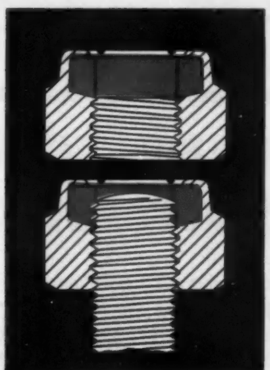


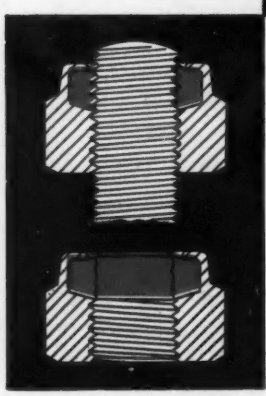
Several things make this nut unusual. For instance, you can "stop" it at any position on the threaded length of the bolt . . . or wrench it tight against the work where it protects bolt threads against corrosion and prevents liquid leakage. No matter where you leave it on the bolt, it will remain tight in that exact position, even though you subject it to heavy vibration and shock loads. But use a wrench on it and it comes off as easily as it went on. The red locking collar is nondestructive—does not gall bolt threads or remove plating. You can remove it and re-use it again and again.

What gives it its grip?

1 The locking collar is unthreaded and elastic. It has an inside diameter smaller than the major diameter of standard bolts.

2 The bolt impresses a mating thread into the collar and the resulting compressive forces exert a constant friction grip on the bolt. . . .





3 and exert a downward thrust bringing the lower flanks of the bolt thread into firm metal to metal contact with the matching nut threads, eliminating normal axial play.

4 Nut is removable and reusable . . . the Red Elastic Collar retains its grip after repeated usage.

Will it hold under ALL conditions?

The locking principle of the Elastic Stop® nut has been tested and proved by over 25 years of actual field service. Elastic Stop nuts are used on locomotives . . . and pile drivers. They fasten hedge shears and harvesters, drilling rigs and washing machines, trucks and roller skates. And no Elastic Stop nut customer has ever stopped using them because of unsatisfactory performance.

What about sizes and materials?

Elastic Stop nuts are available from a watchmaker's 0-80 all the way to 4"—in materials that include stainless steel, brass, aluminum and other alloys. Protect your product with "fastener insurance." Try Elastic Stop nuts on trouble spots, whether to protect expensive heavy equipment from costly downtime or to guarantee the accuracy of delicate electrical equipment by maintaining precision adjustments. We'll supply free test samples.

ESNA® TRADE MARK

ELASTIC STOP NUT CORPORATION OF AMERICA

Dept. N82-275, 2330 Vauxhall Road, Union, N. J.

Please send the following free fastening information:

☐ ELASTIC STOP nut bulletin

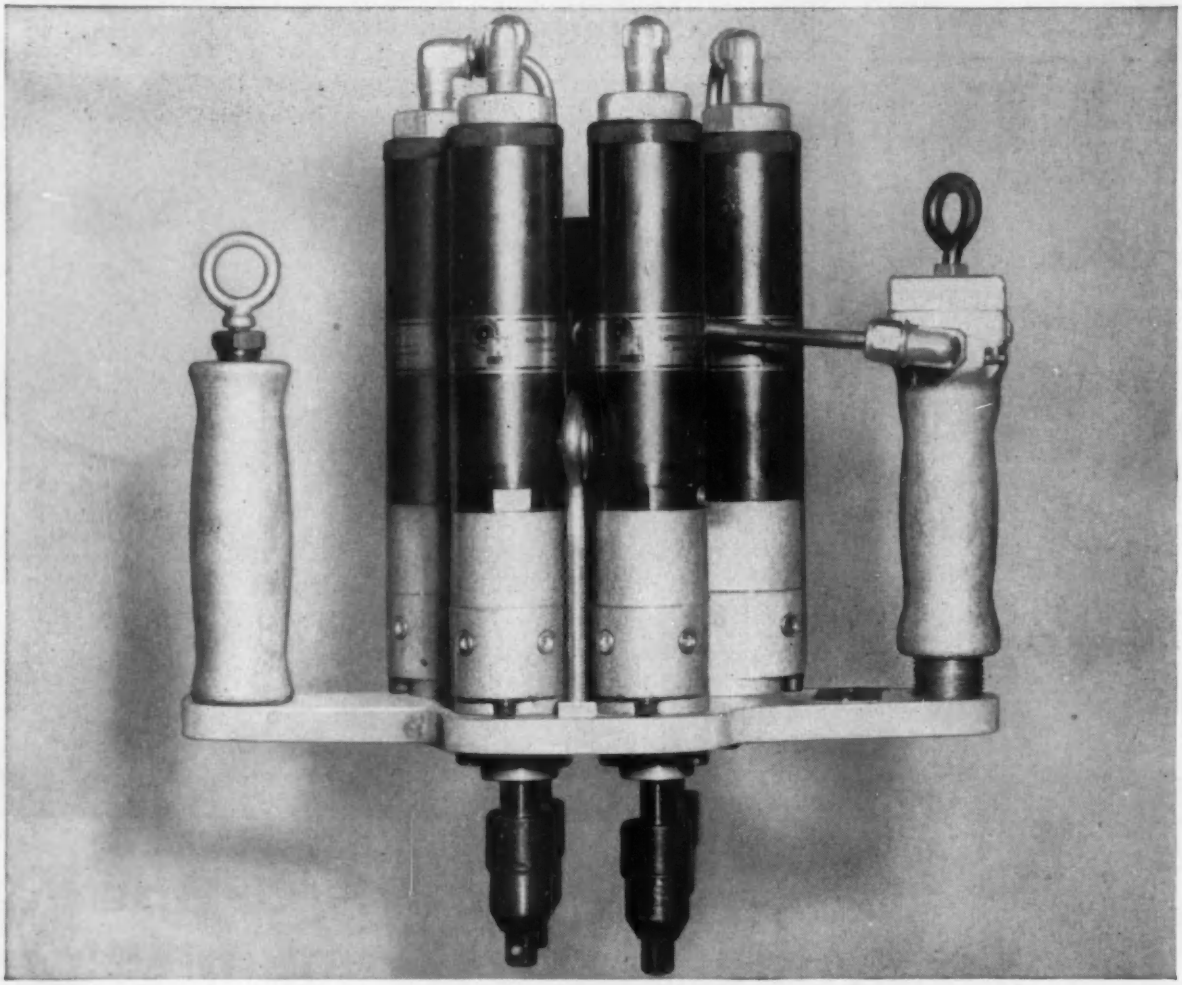
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

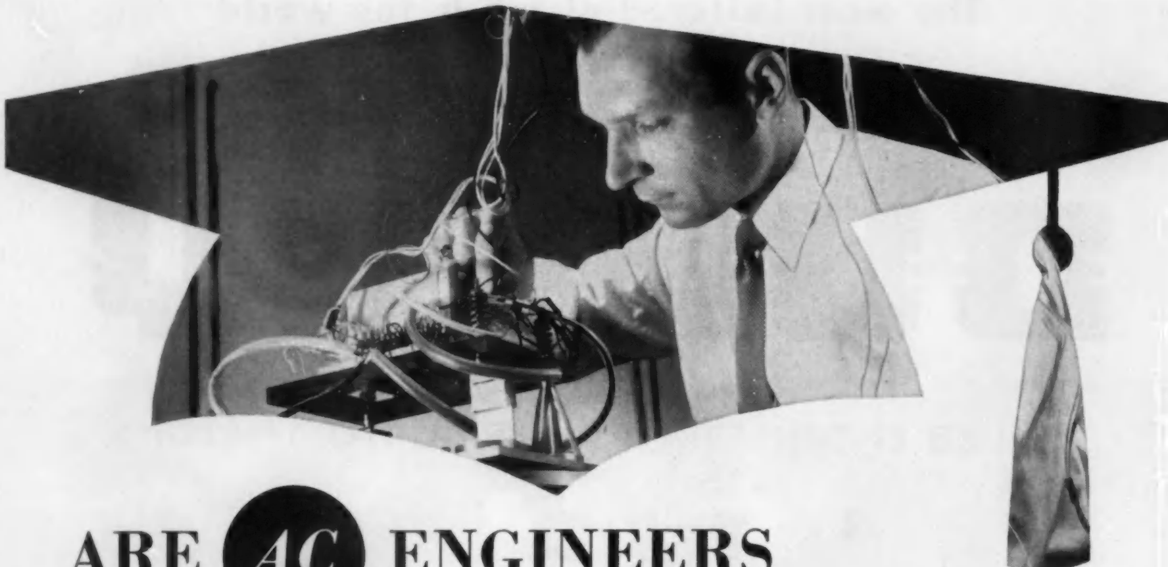
Name ______________________ Title ____________

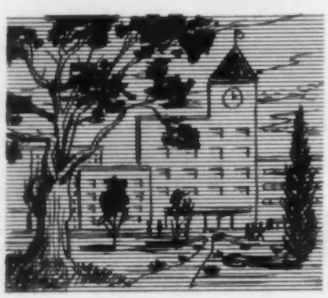
Firm ______________________________________

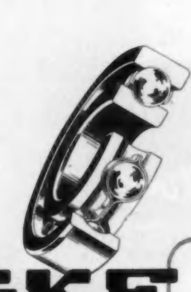
Street _____________________________________

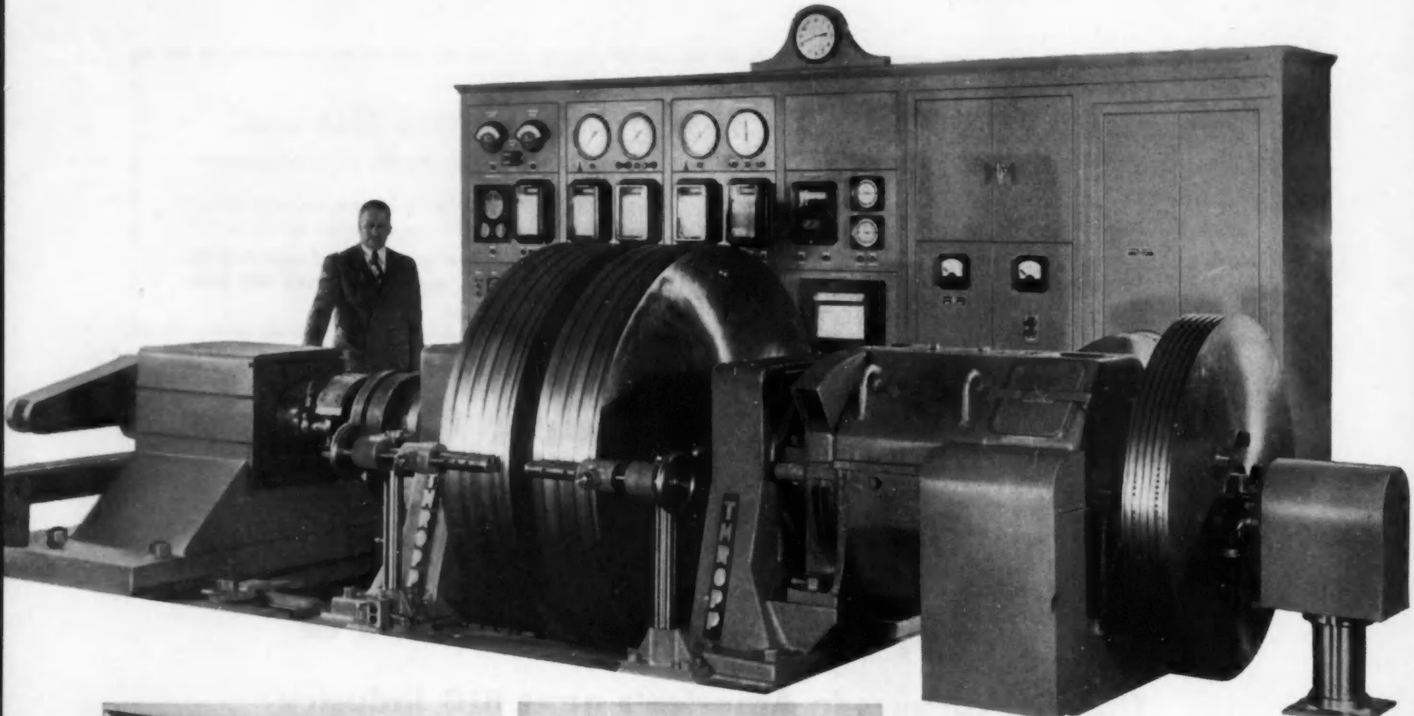
City ______________________ Zone ______ State ______

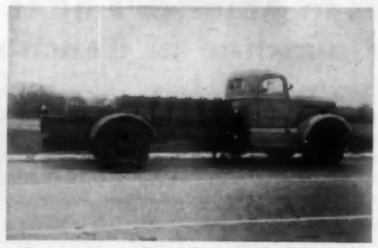












R/M maintains a permanent testing station near Jennerstown, Pa., along U.S. Route 30, considered to be the most severe mountain course of its kind in the U.S.

Huge dynamometer at R/M plant in Passaic, N.J. On this dynamometer, one of the world's largest, and most useful, the performance of friction materials in entire brake and clutch assemblies can be thoroughly tested.

HOW R/M SETS THE PACE IN FRICTION MATERIAL DEVELOPMENT

Lab and field testing solves problems you may be facing now

The one sure way to learn how friction materials will perform is to test them on a dynamometer or a vehicle. That's why Raybestos-Manhattan, world's leading maker of friction materials, has the world's most complete, most adaptable, testing facilities.

R/M laboratory testing equipment ranges from comparatively simple machines to giant inertia dynamometers, including one of the biggest ever made.

For road testing on both level and high mountain country, R/M has its own fleet of vehicles. At the well-known Jennerstown Mountain Testing Area, R/M maintains a year-round testing station where friction parts can be tried and proven under the most rigorous driving conditions . . . on grades up to 15%.

Just what does this R/M testing mean to the O.E.M.? It means, first, that friction material performance in full-size brake and clutch assemblies can be thoroughly and precisely determined for you by R/M engineers. And second, perhaps even more important, it means that R/M has acquired a wealth of knowledge about friction material behavior that could solve problems you may be facing.

If you are working with friction materials, call in an R/M representative now. The facilities of R/M's seven great plants, with their research and testing labs, are as near as your telephone.

Write now for your free copy of R/M Bulletin No. 500. Its 44 pages are loaded with practical design and engineering data on all R/M friction materials.

R/M

FIRST IN FRICTION

THE TRADEMARK THAT SPELLS PROGRESS IN FRICTION MATERIAL DEVELOPMENT

RAYBESTOS - MANHATTAN, INC.

EQUIPMENT SALES DIVISION: Bridgeport, Conn. • Chicago 31 • Cleveland 16 • Detroit 2 • Los Angeles 58

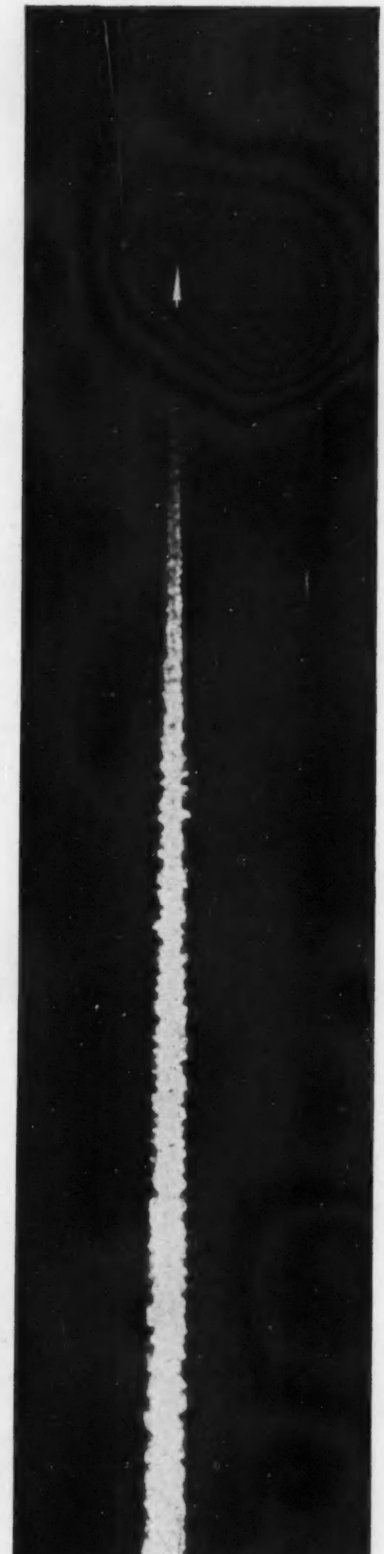
FACTORIES: Bridgeport, Conn.; Manheim, Pa.; Passaic, N.J.; No. Charleston, S.C.; Crawfordsville, Ind.; Neenah, Wis.; Raybestos-Manhattan (Canada) Limited, Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Brake Linings • Brake Blocks • Clutch Facings • Sintered Metal Products • Industrial Adhesives
Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics • Rubber Covered Equipment
Abrasive and Diamond Wheels • Laundry Pads and Covers • Bowling Balls


Sealed Power announces the first
Stainless Steel
Oil Ring
SS-50U
Stainless Steel maintains tension!
Stainless Steel resists corrosion!
Stainless Steel resists wear!
DESIGN ADVANTAGES:
RADIAL PRESSURE
Circumferential abutment type design makes the ring independent of contour and depth of piston groove. Consequently, it can exert its pressure uniformly and can conform more readily to the bore. The SS-50U is easy to assemble on piston.
CHROME RAILS
Full chrome-faced side rails assure long ring life. Special treatment of these rails produces quick seating.
BETTER OIL CONTROL
assured by uniform radial pressure. Full flow of oil back to crankcase obtained by maximum ventilation.
SIDE SEALING
is assured by the proper axial pressure of rails against sides of groove. This provides smoke control under high vacuum conditions.
SEALED POWER CORPORATION • MUSKEGON, MICHIGAN • ST. JOHNS, MICHIGAN • ROCHESTER, INDIANA • STRATFORD, ONTARIO
DETROIT OFFICE • 7-236 GENERAL MOTORS BUILDING • PHONE TRINITY 1-3440
Sealed Power Piston Rings
PISTONS • CYLINDER SLEEVES
Leading Manufacturer of Automotive and Industrial Piston Rings Since 1911
Largest Producer of Sealing Rings for Automatic Transmissions and Power Steering Units

Engineers wanted for this assignment:

TAKE MAN HIGHER...FASTER ...THAN EVER BEFORE



The men who create tomorrow's hypersonic, high flying aircraft will have to engineer them to withstand the weird phenomena of the stratosphere. Here in deep blue space, violent 200-mile-per-hour winds fight each other. Fantastic air temperatures and aerodynamic heating become incredible, contradictory forces.

The airplane of the future will have to overcome *all* the problems of this eccentric environment, and do one more thing —house and protect a human pilot.

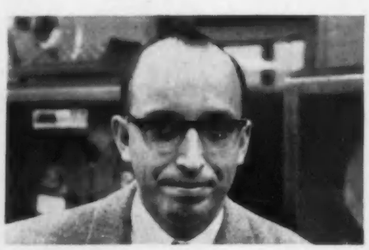
At two times the speed of sound the lowest temperature anywhere on the airplane is 250°—hot enough to rob aluminum alloy of 20% of its strength. At Mach 3 temperatures zoom to a blood-boiling 650°. And yet thermodynamics is just one package of problems confronting today's aircraft engineer. There are many more to be unwrapped before this space-age accomplishment is real.

The aeronautical researcher has, however, an outline picture of his airplane of the future. He knows that its configuration will be designed to reduce friction ... its wing will be razor-thin ... the nose needle-sharp to avoid detached shock waves. He also knows that his brainchild will have to prove itself high above the atmosphere!

One day soon this missile-like airplane will take man where he's never been before ... to the very frontier of space.

If you accept this challenge we promise you a management climate that stimulates personal growth and rewards initiative. Engineers have constantly guided the long-range technological advancement of North American where research and development on the X-15—a manned aircraft for the investigation of speeds and temperatures at very high altitudes—is now in progress.

Write today for full particulars to: Mr. T. J. Wescombe, Engineering Personnel Manager, Dept. 2-SAE, North American Aviation, Inc., Los Angeles 45, California.

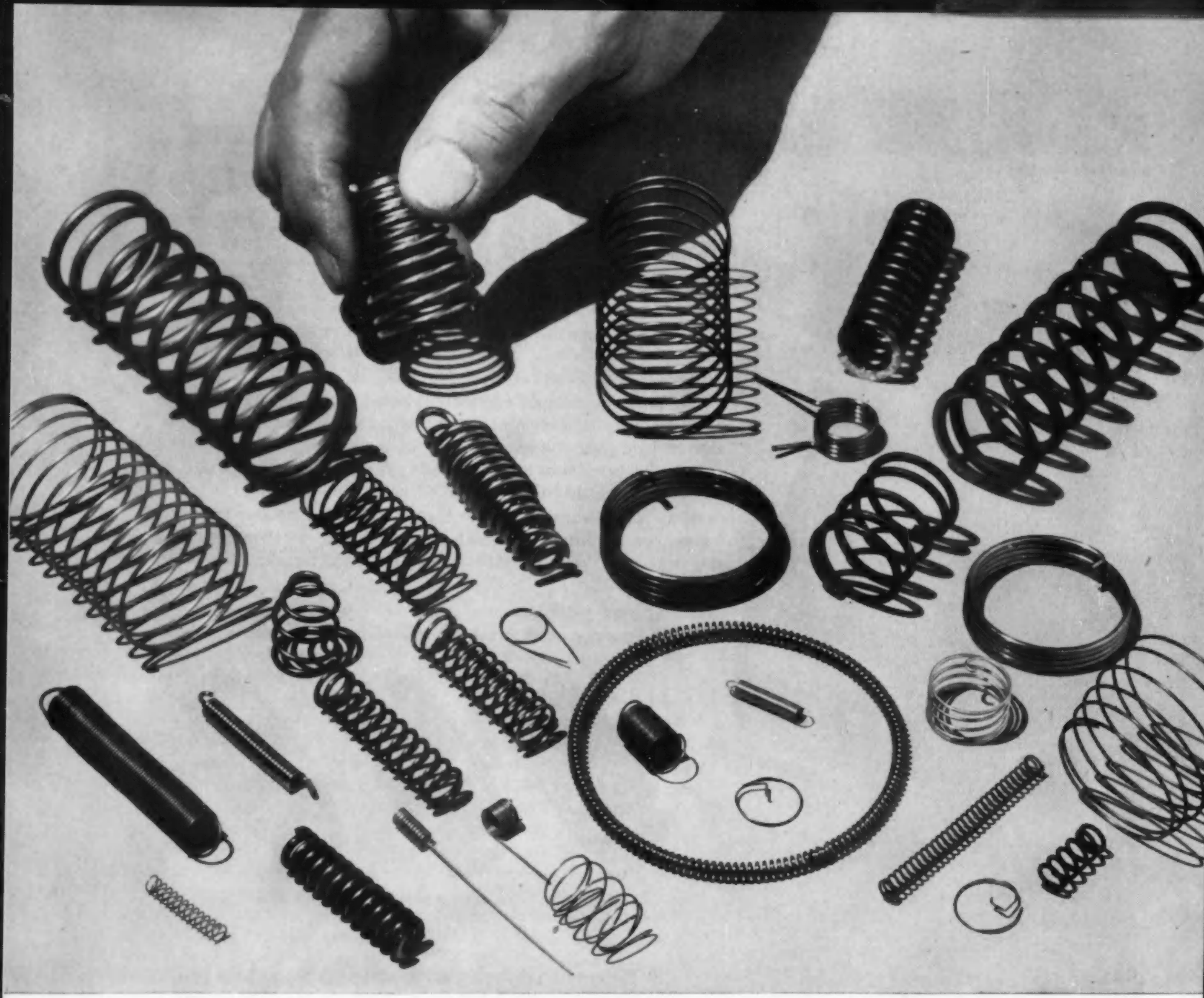


CHUCK PRICE earned a BS in 1944, MS in 1947, and a PHD in Mathematics in 1950—all from the University of Chicago. In 1953 he joined North American's Advanced Design Department. Since then he has earned three promotions and is now a Group Leader supervising 36 engineers working on new aircraft design. His Group's objective — to select the aircraft configuration best suited to perform a specific mission.

MIT graduate **HAROLD RAIKLEN** received his BS in Mechanical Engineering in 1947—his MS two years later. His first North American assignment was to analyze and test dynamic stability and response of powered flight controls. Today, less than four years after joining the Company, Hal heads a section devoted to design and study of mechanized components, including flight control systems — his third supervisory position.

NORTH AMERICAN AVIATION, INC.

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD



How the right "COAT" solves many spring problems

● Unless you yourself go in for forming wire springs, you have no idea what a tricky business it is. For one thing, as every fabricator knows, it takes extreme uniformity in the wire to obtain the precise dimensions and the exacting tension, torsion or compression characteristics so often required.

But uniformity alone won't always do the trick! As a leading supplier of special wire for tougher-than-usual spring requirements, National-Standard has delved deep into production problems and has come up with answers that help many a fabricator hold better to tough specifications and produce faster with less waste and more profit!

Time and again, for example, National-Standard has shown that merely a change in wire *coating* or lubrication quality is of major importance in forming operations. Proper coating also helps gain uniform dimensional response to heat treating. Quite often, in fact, troubles chalked up to wire variance are really the fault of improper coating or finish.

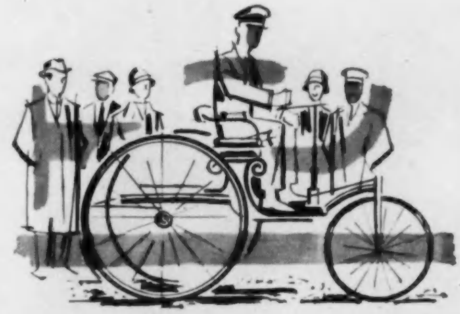
Helping fabricators solve problems and cut costs is a National-Standard specialty. We're geared for it and make a point of it. Try us and see!

NATIONAL STANDARD

DIVISIONS: NATIONAL-STANDARD, Niles, Mich.; *tire wire, stainless, music spring and plated wires* • WORCESTER WIRE WORKS, Worcester, Mass.; *high and low carbon specialty wires*
WAGNER LITHO MACHINERY, Secaucus, N. J.; *metal decorating equipment* • ATHENIA STEEL, Clifton, N. J.; *flat, high carbon spring steels* • REYNOLDS WIRE, Dixon, Ill.; *industrial wire cloth*

MILESTONES IN POWER PROGRESS

(NO. 1 IN A SERIES)



1885 — The first internal-combustion engine car — by Benz

1955—The first creative-packaging of dry-charged batteries was introduced by GLOBE

Historians disagree on the absolute birthday of modern motoring, but Karl Benz did build the first internal-combustion engine car. And there's no argument at all about Globe's *battery* contributions . . . not only pioneering dry-charged batteries, but first to package all elements *together* for the simplest, swiftest battery activation ever known.

It's this fast, this easy, this important . .

Open the compact carton, a complete package of charging ingredients • Take out each plastic bottle of *pre-measured* Spinning Power electrolyte — no waste, no guesswork, no time out to measure • For extra safety slip each bottle into the handy pouring sleeve • Your grip is firm as you snip the bottle nipple and — *Pour!* Battery is *ready for action* with *fresh power.* Because until that instant the battery has been inert — and because *method and ingredients are all together in one package.*

Another milestone in power — another **first** for Globe!

First for fast, low-cost delivery too!

Lightweight plastic electrolyte bottles and compact carton cut shipping costs. Furthermore, Globe's sixteen plants are strategically located for fastest, lowest-cost shipments to all markets — and thirteen (*) are producing dry-charged batteries.

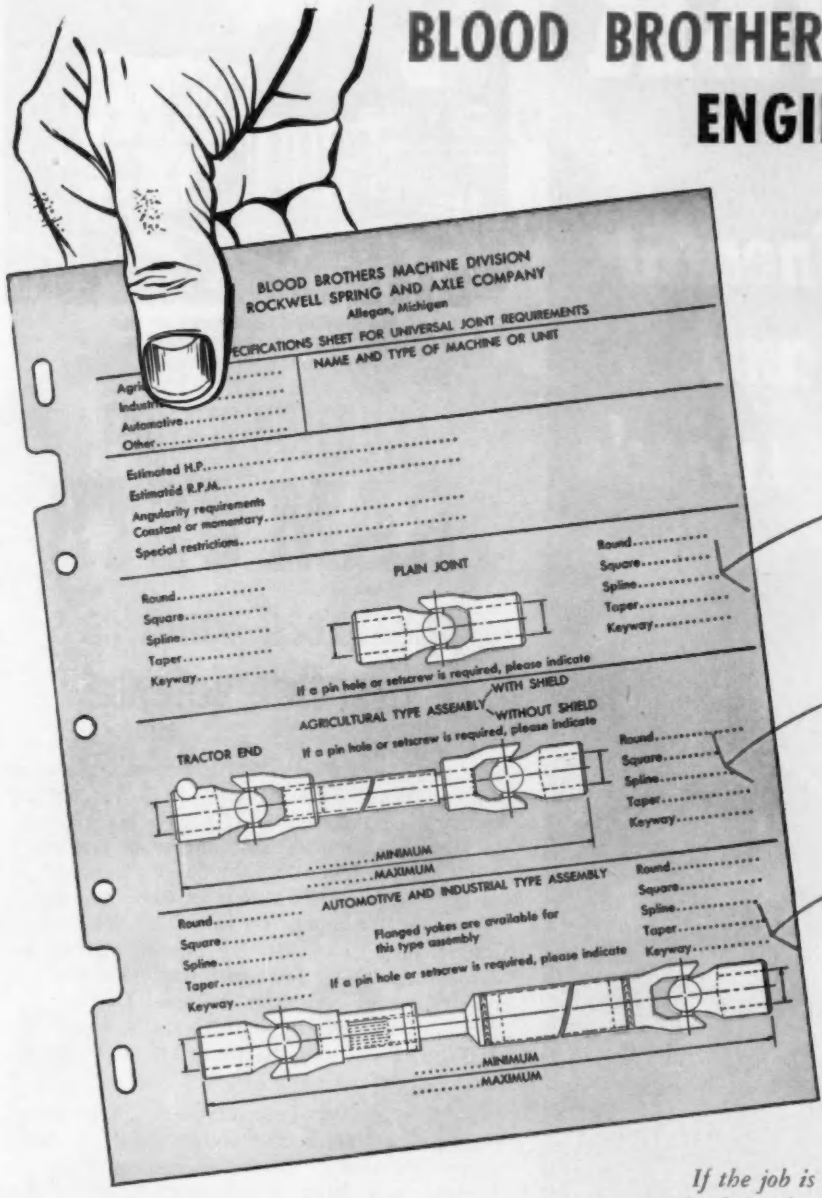
*ATLANTA, GA., *DALLAS, TEXAS, *EMPORIA, KANSAS, *HOUSTON, TEXAS, *LOUISVILLE, KY., *MEDFORD, MASS., *MEMPHIS, TENN., *MILWAUKEE, WIS., *MINERAL RIDGE, OHIO, *PHILADELPHIA, PA., *REIDSVILLE, NO. CAROLINA, *SAN JOSE, CALIF., *HASTINGS-ON-HUDSON, N. Y., LOS ANGELES, CALIF., OREGON CITY, ORE., AJAX (ONTARIO) CANADA

SPINNING POWER · GLOBE-UNION · SPLIT-SECOND STARTING

GLOBE-UNION INC.

MILWAUKEE 1, WISCONSIN

If it's Petroleum-powered there's a GLOBE-BUILT BATTERY right from the start!



BLOOD BROTHERS makes your ENGINEERING JOB *EASIER*

. . . regardless of whether your project requires a single universal joint such as this

. . . a complete agricultural type assembly

. . . or an automotive or industrial truck propeller shaft like this

Just fill out and mail a sheet like *THIS*—and let BLOOD BROTHERS' Engineers propose a helpful, practical solution to your Drive Line Problem!

If the job is unusual or the problem unique, Blood Brothers' experience can be invaluable.

Many engineers are saving valuable time—right at the start of a project—by filling out and returning a "Spec Sheet" like this to Blood Brothers. Why not try it?

With your power transmission requirements in mind, our engineers will make recommendations and submit engineering drawings. You save designing and drafting time, and perhaps forestall problems, by having the initial teamwork of experienced specialists.

This service is offered without extra charge because *we* can work more efficiently with all the facts in hand.

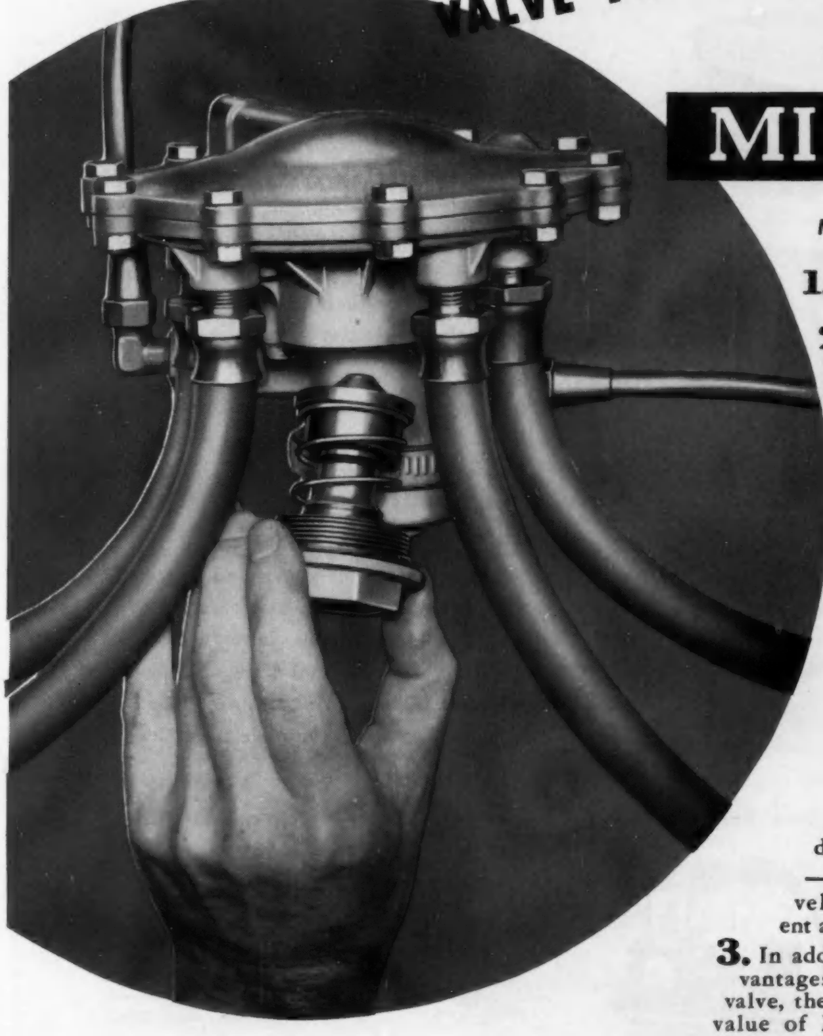
Blood Brothers builds ***more standard types and sizes*** of universal joints than any other manufacturer (from 300 up to 89,300 torque inch pounds continuous load).

Why not use this experience on your next project? ***Write Blood Brothers today for your handy "Spec Sheets."***

BLOOD BROTHERS MACHINE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

IF YOU OPERATE TRUCK-TRAILERS YOU NEED THE BEST EMERGENCY RELAY VALVE YOU CAN BUY . . .



AND THAT'S

MIDLAND

Midland's New Emergency Relay Valve Is Best For You Because—

1. It gives you 100% protection against "bleed-back".

2. It goes beyond ICC requirements—gives you many PLUS features like these:

—**Midland** valve can be quickly, easily serviced. You can remove and replace cartridge in a matter of minutes, *without disconnecting any lines or fittings.* (*See photo.*)

—**Operation** of Midland valve is automatic, yet *gradual.* (Automatic application of trailer brakes is *instantaneous,* of course, if trailer separates from tractor.) Valve's dual compensating feature provides automatic, gradual application of trailer brakes if pressure in the system drops below 45 p.s.i.

—**Midland** valve is designed to reduce application and release time.

—**Midland** valve safeguards against vehicle driveaway without sufficient air in the system.

3. In addition to the actual operating advantages of Midland's emergency relay valve, there's the protection and dollar value of Midland's nation-wide service and parts facilities—hundreds of Midland distributors in the United States, Canada, and abroad.

Be safe, be satisfied—specify Midland Emergency Relay Valves on all orders of new equipment.

MIDLAND

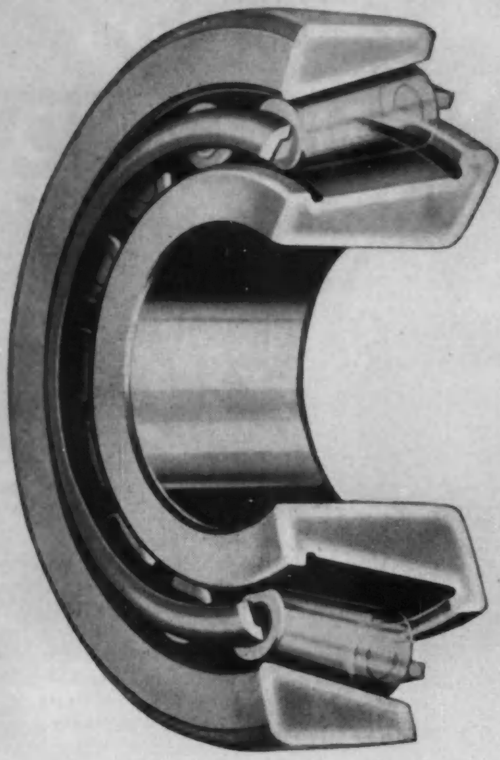
STEEL PRODUCTS CO.

THE MIDLAND STEEL PRODUCTS COMPANY

Owosso Division • Owosso, Michigan

Export Department: 38 Pearl Street, New York, N. Y.

There's a BOWER TAPERED ROLLER BEARING engineered to fit <u>your</u> product



Types and sizes to fit a wide range of tapered bearing applications

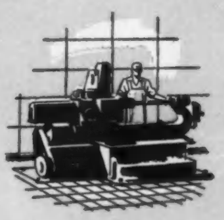
There's no need to compromise with bearings! Whatever your product, if it uses tapered roller bearings, call in a Bower engineer for expert help on selecting the exact type and size you need.

Depending on your own particular needs, he'll make sure you get the exact size and type—selected from Bower's complete tapered line—engineered to assure maximum performance in your application.

Most important of all, when you specify Bower tapered roller bearings for your product, you get all the advantages of advanced Spher-O-Honed design—less maintenance, longer life, smoother operation. Get the full facts on the *complete* Bower line.

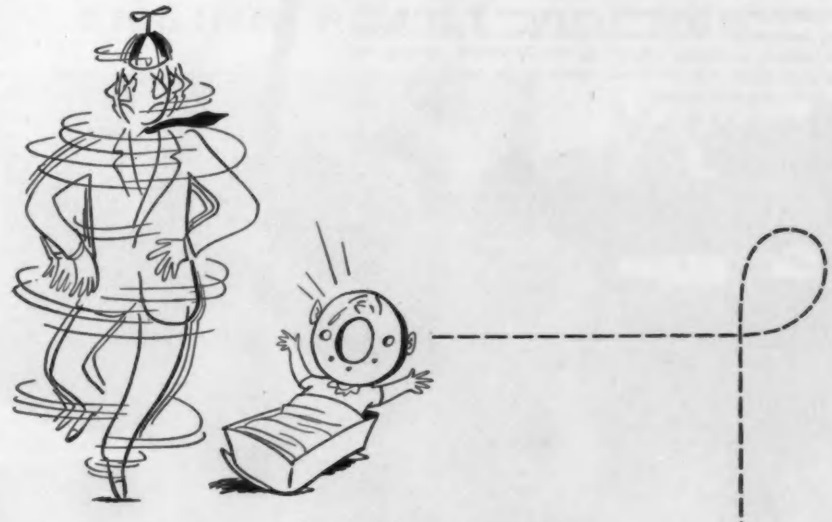
Tapered, Straight and Journal Roller Bearings for every field of transportation and industry



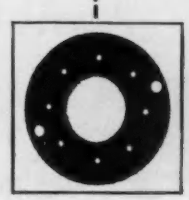



BOWER **ROLLER BEARINGS**

BOWER ROLLER BEARING DIVISION • FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICH.



a FRETTING-CORROSION problem had him in a spin



Finding a wear-resistant coating for turbine engine shaft seals posed a serious problem for an aircraft engine manufacturer. Even the hardest alloys were subject to fretting-corrosion and had to be replaced after a few hours of service.

This fretting-corrosion problem was solved by having the bearing surface of the seal Flame-Plated by LINDE. By this special detonation process, particles of tungsten carbide are literally *blasted* onto almost any metal surface. Most important, the temperature of the part being plated never exceeds 400° F., so there is little chance that the base metal will warp or that its metallurgical properties will be changed. Flame-Plated tungsten carbide coatings can be applied in thicknesses from .010 to .002 inches. Coatings can be used in the as-coated condition (125 microinches rms) or ground and lapped to a 0.5 microinch finish.

If your design involves metal parts subject to extreme wear, heat, or fretting-corrosion, perhaps Flame-Plating can eliminate some or all of your "headaches"—or make possible some completely new idea.

To find out, write us about your wear problem or request a free copy of LINDE's booklet, "Flame-Plating," F8065. Address Flame-Plating Department.

Flame Plating by *Linde*

LINDE AIR PRODUCTS COMPANY

A Division of Union Carbide and Carbon Corporation

30 East 42nd Street UCC New York 17, New York

In Canada: Linde Air Products Company, Division of Union Carbide Canada Limited, Toronto

The term "LINDE" is a registered trade-mark of Union Carbide and Carbon Corporation

ROADBUILDING EQUIPMENT sets the pace for modern highway construction. It is exposed to all kinds of weather, needs the positive protection offered by the Granodine coating and the paint finish it so tenaciously bonds to the metal.

ACP *Granodine*® ANCHORS THE FINISH ON FARM AND CONSTRUCTION EQUIPMENT

FARM EQUIPMENT, TOO, must be protected under good and bad weather conditions. ACP Granodine phosphate coating under paint affords this extra needed protection.

TRUCKS AND TRACTOR-TRAILERS work night and day all year round. Ice and snow, rain and heat attack the paint finish. ACP Granodine anchors it.

Weather, dirt and abrasion are archenemies of farm and construction equipment. To protect the metal, a durable and tenacious paint finish is required. ACP Granodine provides the base for such a finish. It chemically converts steel surfaces to a nonmetallic phosphate coating. This base not only increases the adhesion of the finish, but also greatly improves the corrosion resistance of the finishing system even when used in conjunction with a relatively thin and flexible paint film. ACP Granodine coatings are economically applied to steel surfaces by dipping, spraying or brushing.

LEARN ALL ABOUT ACP GRANODINE. Bulletin 1380 describes the various types of ACP Granodine and gives information which will help you select the proper type for your particular application. Write for your copy today.

AMERICAN CHEMICAL PAINT COMPANY, Ambler 36, Pa.

DETROIT, MICH. • ST. JOSEPH, MO. • NILES, CALIF. • WINDSOR, ONT.

CHEMICALS ACP PROCESSES

New Chemical Horizons for Industry and Agriculture

In the Spectacular PLYMOUTH ENGINE PLANT you see

VICKERS® HYDRAULICS

Wherever You Look

(Above) View of Plymouth Engine assembly line

Plymouth Engine Plant is 980' long and 500' wide. Indicative of its scope is crankshaft machining requiring 4500 linear feet of automation composed of 385 individual units. Plant capacity is 150 engines per hour.

In the new Plymouth "Qualimatic" Engine plant you see Vickers Hydraulics on every side. Hundreds of machines in this latest and greatest example of automation are Vickers equipped.

Both builders and users of production equipment appreciate the significant advantages of Vickers Hydraulics . . . advantages that help produce better products at lower cost.

A specific need in the Engine Plant is standardization on a few basic hydraulic units to keep down parts inventories. The Vickers line makes standardization easy. Also desirable are hydraulics in units quickly demountable . . . so that by replacing units, repairs on the job are avoided and costly downtime reduced. Vickers has extensively developed demountable unit construction.

Whether automated or not, more and more plants have more and more Vickers Hydraulics. For further information, write for Catalog 5002B.

VICKERS HYDRAULICS is used on machines supplied by these Companies to Plymouth Engine Plant

American Broach & Machine Co.	Lees-Bradner Company
Barnes Drill Company	Michigan Drill Head Co.
Bilt-Rite Tool & Machine Co.	Micromatic Hone Corporation
Buhr Machine Tool Company	Micro-Poise Engineering & Sales Co.
Colonial Broach & Machine Co.	Modern Industrial Engineering Co.
Crankshaft Machine Company	The Motch & Merryweather Machinery Co.
The Cross Company	Norton Company
Ex-Cell-O Corporation	A. P. Schraner Co.
Fitchburg Engineering Corp.	The Sheffield Corporation
Greenlee Bros. & Company	Snyder Tool & Engineering Co.
Industrial Metal Products	Sundstrand Machine Tool Co.
The LaPointe Machine Tool Co.	Jervis B. Webb Co.
Landis Tool Company	The Wickes Corp.
The R. K. LeBlond Machine Tool Co.	Wilson Automation Co.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1440 • Detroit 32, Michigan

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7545

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

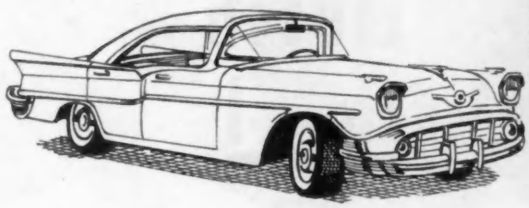
Rapidly becoming the

Standard of the Automotive Industry

INCREASES ENGINE LIFE UP TO 400%

STERLING'S great "Conformatic" piston with "Intra-Cast" steel ring groove liners give sensationally longer life to rings and grooves—

Recommended clearances for "Conformatic" pistons are from 0 to ½ thousandth inch. This clearance is maintained hot and cold providing unbelievable bore stability.



Sterling's revolutionary *Conformatic* piston already has been accepted and is now being used in a number of America's finest and most popular passenger cars.

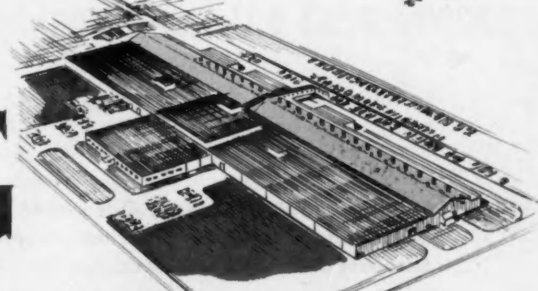
STERLING'S CONFORMATIC PISTON WITH INTRA-CAST STEEL LINED GROOVES

prevents frictional horsepower loss, reduces oil consumption to an absolute minimum, and prolongs engine life up to 400%. *Intra-Cast* and *Conformatic* are registered trade names of STERLING Aluminum Products Inc.

STERLING

ALUMINUM PRODUCTS INC.

ST. CHARLES, MISSOURI



NEW MANUFACTURING FACILITIES FOR STERLING ALUMINUM

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Complete facilities for all your valve requirements at the Valve Division

More than 500,000 square feet of production and laboratory area at the new Valve Division plant are used exclusively for developing and making engine valves, seat inserts and other valve train components.

Back of these new facilities are our 50 years of experience in producing valves and valve-train parts for every car, truck, industrial and aircraft engine manufacturer.

Here is experience you can use to advantage in your new engine designs.

Valve Division *Thompson Products, Inc.*

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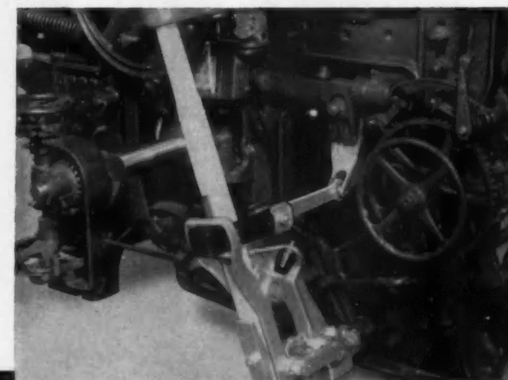
Simplification and Improvement

HEIM *Unibal* ROD ENDS

Make it possible to reduce the number of component parts formerly used in the link-type parallel and the thread cutter mechanisms on Draper looms. The result of this simplification has been an improvement in the overall operation of the loom.

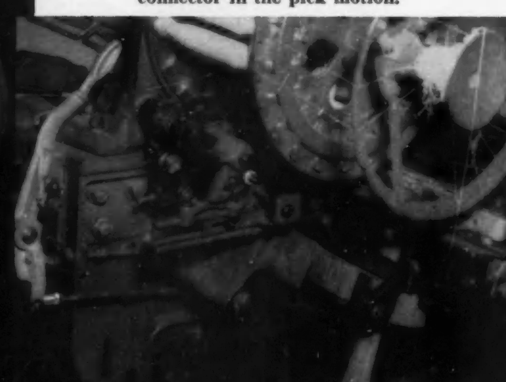
What is the Heim Unibal?

The outer member can be male (for attaching to a tubular rod), female (for attaching to solid rod stock), or a special shape to fit in with a particular design — but there is only one ball, and it rotates in bronze bearing inserts to correct misalignment in every direction. This Unibal construction provides a large surface supporting area to carry heavier loads. Here is a stock part, made in a wide range of sizes, which can take the place of a specially made assembly and perform better and smoother.



Heim Unibal Bearing used in the lug strap connector in the pick motion.

Heim Unibal Rod End



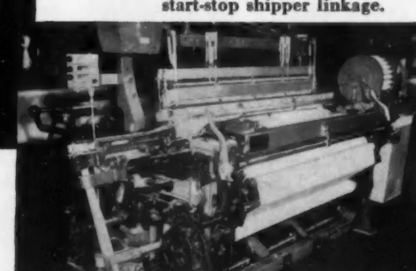
A pair of ¼" Unibal units are used in the thread cutter mechanism.

Four Heim female rod ends are used in the start-stop shipper linkage.

For the transmission of power at varying angles, consider Heim Unibal Spherical Bearing Rod Ends

Write for the Heim catalog.

Ask for any engineering aid.



Draper X-2 Model loom

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2. Famous "p" series power brakes

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4. Free rotating brake shoe rollers

5. Self-aligning cam-shaft brackets

6. 100% heat-treated brake camshafts

7. Deep case hardened cam roller face

The new TK-500 Series Trailer Axle is the lightest for its capacity ever built. Weight savings are accomplished entirely through Timken-Detroit® superior design and construction, with no reduction in strength or quality! Rigorous torture tests—both in the field and in the laboratory—prove the Timken® TK-500 gives longer, more dependable economical service.

For extra payload pounds—extra dependability—extra-long operating life—specify Timken TK-500 Series Trailer Axles.

PLUS...

- ★ New lightweight steel hubs
- ★ New lightweight ribbed brake drums
- ★ New lightweight pressed steel brake shoes
- ★ Lightweight nylon camshaft bushings
- ★ Lightweight fiber glass dust shields

TDA plants at: Detroit, Michigan Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

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WORLD'S LARGEST MANUFACTURER OF AXLES FOR TRUCKS, BUSSES AND TRAILERS


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. . . but all different
Leather can be impregnated by many materials, four of which are shown here. Of the numerous compounds based on these materials, only one will best qualify your packing or oil seal to withstand the pressures, retain or seal the medium and meet the other requirements of your application. Selection of the proper leather and impregnant for your operating conditions is a job that IPC specializes in. Let our technical staff analyze your requirements and custom-engineer the best impregnated leather packing or oil seal for your application.
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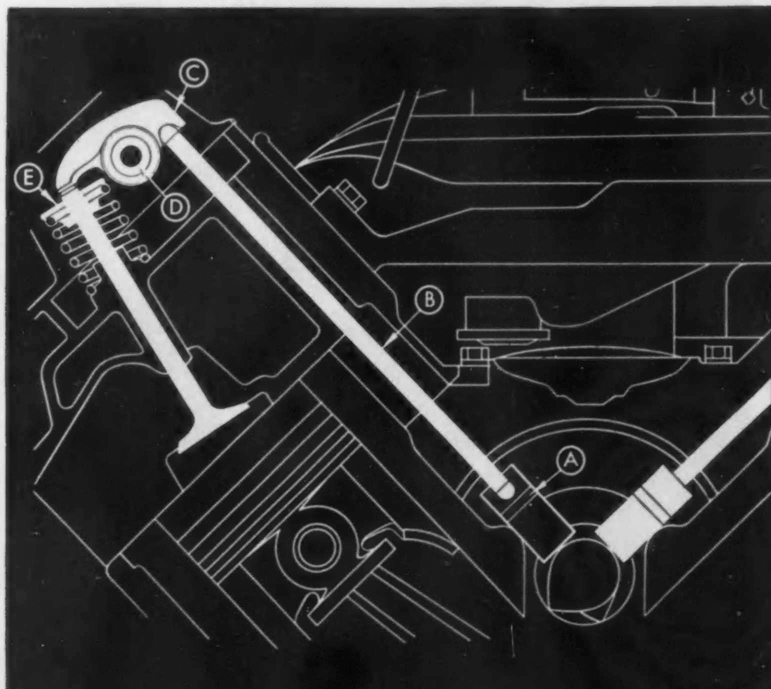

Chicago valve train parts in a typical V-8 automotive engine: (A) Hydraulic tappet, (B) push rod, (C) rocker arm, (D) rocker shaft, (E) valve spring retainer.

When it comes to valve gear, leading engine makers come to

CHICAGO

Here at Chicago you'll find a single source for everything you need in valve gear. These specialized facilities are solving problems and saving money for leading engine manufacturers . . . and can do the same for you.

Design and Engineering—at Chicago you'll find valve gear engineering experience in depth . . . men who understand your problems and will work with your engineering staff in designing cam shafts and complete valve gear assemblies for any type of engine.

Manufacturing—Chicago is a leading manufacturer of valve train parts. Our complete line includes precision-made hydraulic and mechanical tappets; push rods in both lightweight tubular and solid styles; valve adjusting screws including new self-locking screws that cut assembly costs; valve spring retainers; rocker arms and rocker shafts.

Testing—we have complete laboratory and engine testing facilities.

For the full story of how we can serve you, write our Tappet Division.

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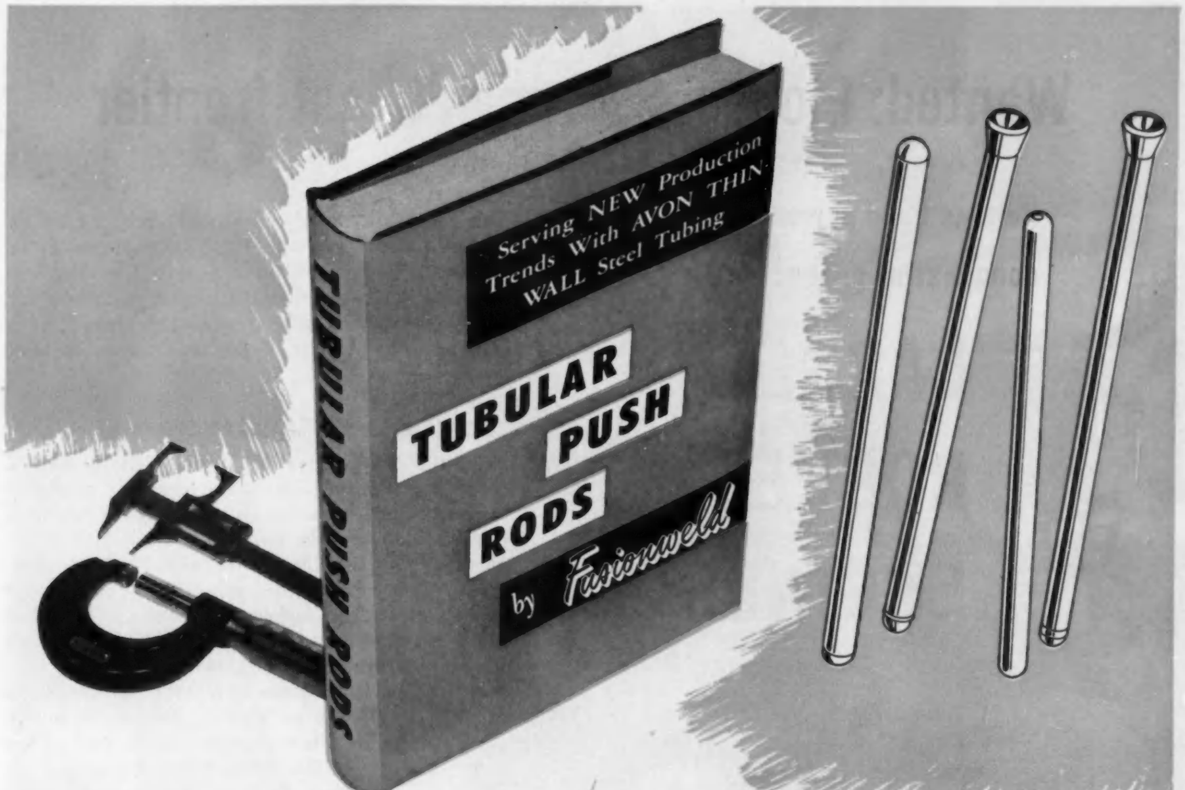

HOW *Fusionweld* MEETS THE CHALLENGE

The above cutaway tubular push rod section with swaged end illustrates one type of push rod design made and fabricated by Avon, then cyanide hardened. It has a low cost factor combined with great strength and toughness, plus essential concentricity.

Special hardened steel inserts (at left) provide other styles of design. These are spot welded in the tube ends, with a maximum runout of .020, to match rigid concentricity tolerances. Illustration at right shows push rod with welded insert subjected to pull-out test of 1500 pounds, which greatly exceeds critical automotive requirements.

Avon's widely accepted Fusionweld Tubular Push Rods have successfully supplanted the heavier, old style solid push rods. Startling economies, plus important improvements in engine performance today place Fusionweld push rods in the forefront of this accepted method of valve accentuation. Fusionweld has today succeeded in creating an enviable reputation for producing top quality, vibration-proof, thin-wall steel tubing. Its exclusive method of hi-cycle resistance welding, coupled with a special process of cold drawing by die sinking now provide a tubing with extreme toughness and hardness to meet the most exacting standards for a fatigue resistant product. Fusionweld's complete homogeneity of grain structure in both wall and weld gives it a new degree of tensile strength and ductility, making it highly resistant to vibration—hence ideal for innumerable automotive applications.

We welcome inquiries on Fusionweld Tubing in random or cut-to-length sizes—or fabricated and formed to your blue print specifications. Sizes 3/16" O.D. to 3/4" O.D. Plain or terne coated. Write for your copy of the Avon Tubing Guide.

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The ring of quality

Colorful, low-cost sidewall rings that can be quickly installed on tires are now contributing to the luxury-look of today's new cars. They're inexpensive, stay brilliant for life, wash bright in seconds, out-last tires. A product of The Bearfoot Sole Co., Wadsworth, Ohio, these rings are available in a variety of colors or in white. They're made of Enjay Butyl Rubber because no other rubber tested could equal its performance in severe laboratory and road tests. The Enjay Butyl label on the Flex-A-Wall® carton assures the buyer of outstanding quality.

Find out for yourself the many technical advantages of Enjay Butyl—the rubber that is outperforming natural and other types of rubber in a wide variety of industrial and consumer applications. For full information, and for technical assistance in the use of Enjay Butyl, write, wire or phone the Enjay Company.

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Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

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Leading tank carrier standardizes on Fuller 8-speed ROADRANGER® Transmissions

Fuller 8-speed, semi-automatic ROADRANGER Transmissions will be *standard* in all new tractors purchased by Leaman Transportation Corporation, Leaman Transportation Company, Inc. and Chemical Tank Lines, Inc. of Downingtown, Pennsylvania.

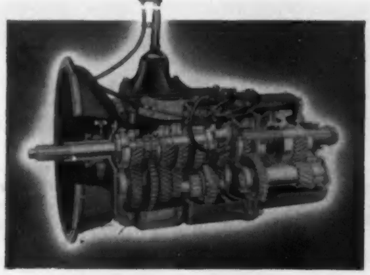
The combination of these three companies comprises one of the largest tank carrier operations in the world. Since 1930 this organization has used hundreds of Fuller Transmissions . . . and recently added 36 new R-46 ROADRANGERS in new White and International Tractors as part of the standardization on this 8-speed model.

Says D. A. (Dave) Ross, Vice President: "We get the best service from the 8-speed ROADRANGERS in our operation. Some have over 150,000 miles on them, and have not been touched. Our maintenance cost is much less . . . in fact, we haven't had any cost to date since we have had *no* trouble.

"50% of all our mileage on the petroleum hauls is with an empty trailer. With the .577 ratio in the rear axle and 10 x 22 tires, we can maintain a good road speed empty in 8th gear . . . at approximately 2000 to 2200 rpm with our gas engines. This results in better fuel mileage and better engine life. And, we are able to maintain a higher rpm at all times under a load. Our drivers now say they wouldn't have any other transmission."

For efficient, dependable operation of your trucks, ask your truck dealer now for full details on the easiest-shifting transmission available for your operation. Specify Fuller ROADRANGER Transmissions for faster trip time, lower fuel consumption, longer engine life, less driver fatigue and greater profits.

Fuller R-46 ROADRANGER Semi-Automatic Transmission



FULLER MANUFACTURING COMPANY
Transmission Division, Kalamazoo, Michigan

Unit Drop Forge Division, Milwaukee 1, Wisconsin • Shuler Axle Company, Louisville, Kentucky (Subsidiary) • Sales & Service, All Products, Western District Branch, Oakland 6, California and Southwest District Office, Tulsa 3, Oklahoma.

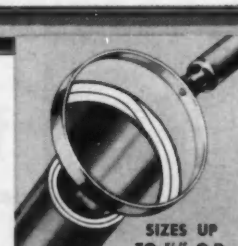
Bundyweld Tubing guides and guards

Above, six-way power seat on the 1957 DeSoto.

In 1957 Imperials, Chryslers, De Sotos, and Dodges, fingertip pressure on the master switch sends Ferro's new power seat adjuster into action. Solenoids engage the proper selective drive; rotating cables transmit torque from electric motor to synchronized slave units in each track. Seat moves up, down, forward, backward; tilts up and forward, down and backward.

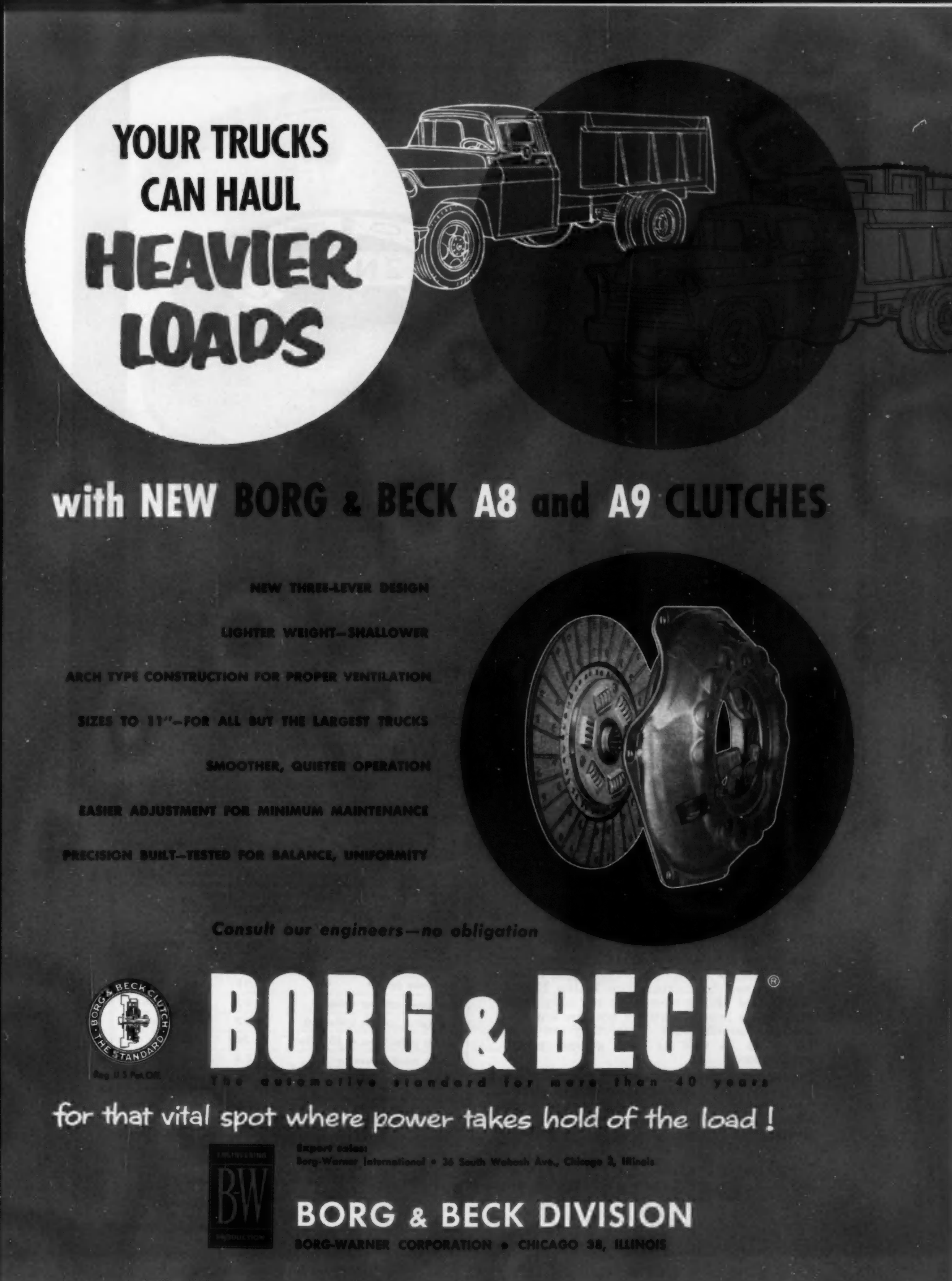
BUNDYWELD IS DOUBLE-WALLED FROM A SINGLE STRIP

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around, laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.



←

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.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... an internal thermal gradient of 1.2° C/watt or less!

Industry's Highest Power Transistors

Large area, thinness and intimacy of collector contact with large copper base provide the efficient thermal transfer.

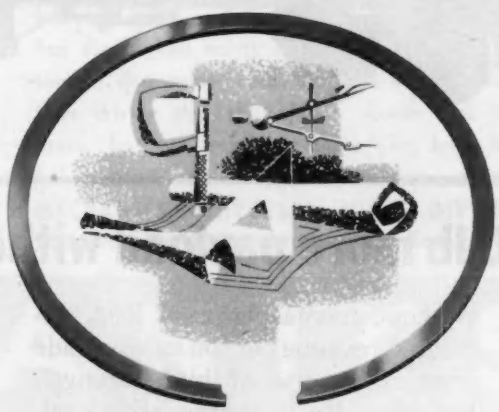
Result—an unusually cool collector junction in the Delco Radio alloy-type germanium PNP power transistor. The Delco Radio 2N173 and 2N174 transistors not only have high power handling ability but also low distortion characteristics. Thus, they are ideal for audio as well as your general power applications.

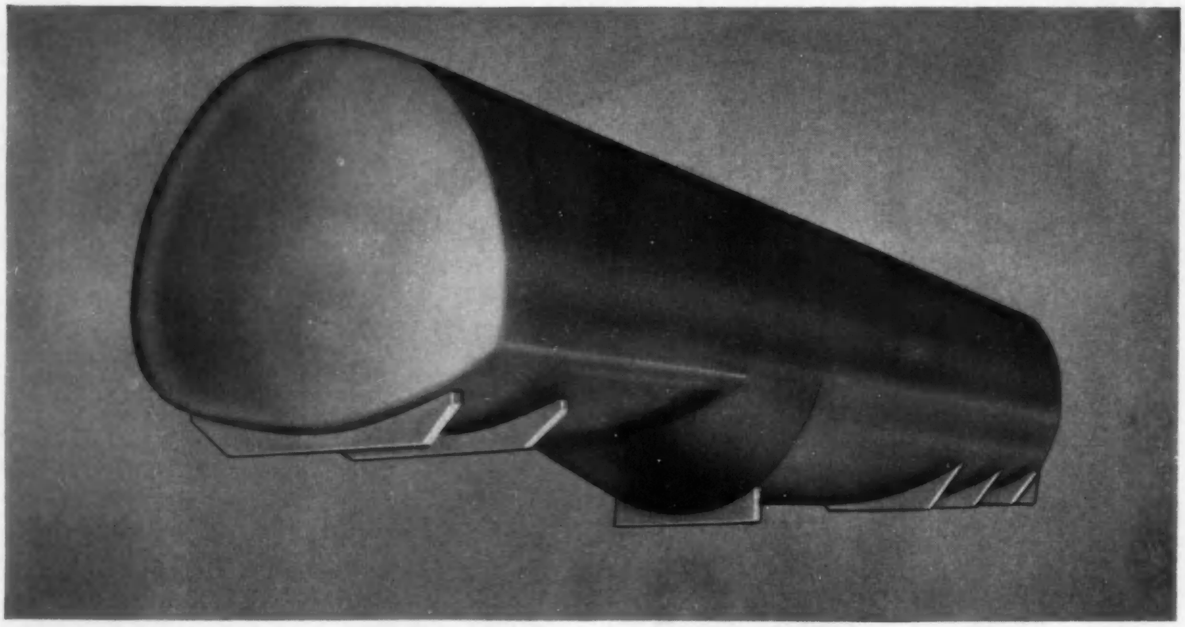
Furthermore, these transistors are normalized to retain their performance characteristics regardless of age. Write for engineering data. Delco Radio transistors are produced by the thousands every day.

TYPICAL CHARACTERISTICS

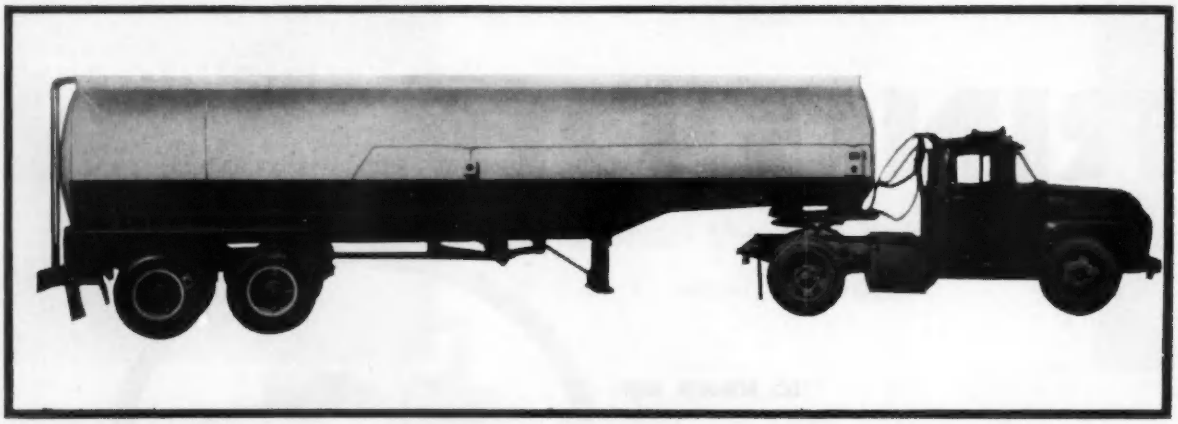
	2N173	2N174	
Properties (25°C)	12 Volts	28 Volts	
Maximum current	12	12	amps
Maximum collector voltage	60	80	volts
Saturation voltage (12 amp.)	0.7	0.7	volts
Power gain (Class A, 10 watts)	38	38	db
Alpha cutoff frequency	0.4	0.4	Mc
Power dissipation	55	55	watts
Thermal gradient from junction to mounting base	1.2°	1.2°	°C/watt
Distortion (Class A, 10 watts)	5%	5%	

DELCO RADIO DIVISION OF GENERAL MOTORS KOKOMO, INDIANA





Nickel-Copper high strength low alloy steel helps Butler Manufacturing Company, Kansas City, Mo., increase capacity of frameless unit . . . enabling transport to haul . . .



2000 lb more payload without changing total weight

Without increasing axle load, increased revenue per ton mile is made practical by use of high strength low alloy steels containing nickel.

Steels of this type show 50,000 psi minimum yield point, or about 1½ times that of the usual carbon grade. This, together with improved corrosion resistance, allows use of thinner sections and permits following either of these two procedures:

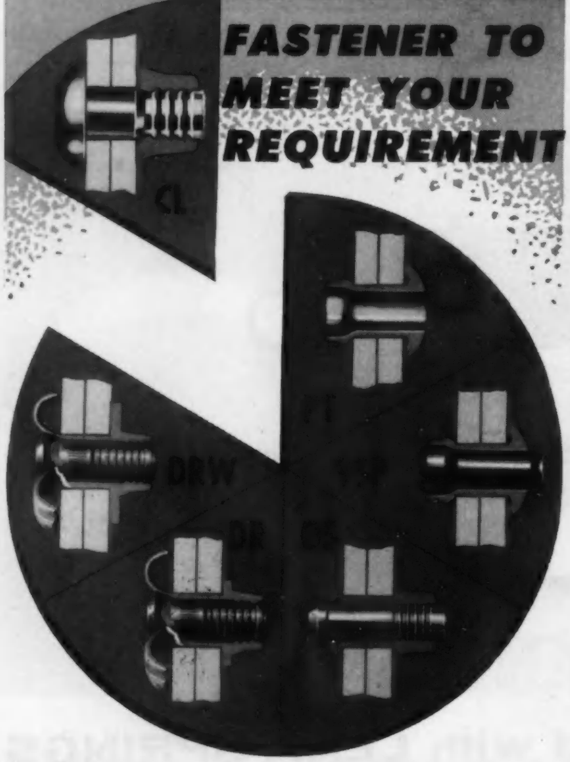
(1) Reduce weight . . . saving tires, brakes and fuel . . . without reducing strength of equipment.

(2) Increase payload capacity without increasing total weight or power demands.

Send for a copy of "Nickel-Copper High Strength Low Alloy Steels."

INCO TRADE MARK **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

there's a **HUCK** **FASTENER TO MEET YOUR REQUIREMENT**



Hundreds of manufacturers here and abroad have found the answer to their toughest fastening problems in HUCK'S complete line of commercial, positive-locking rivets.

Huck fasteners are available in many sizes and shapes to meet the many specialized requirements of industry, from railroads to electronic fabrication. Their fast, simple application and positive locking features save production dollars, time and trouble for their many users—producing a better fastening job.

Write or call for a HUCK sales engineer to discuss your problems. There's no obligation.

U.S. Patent numbers 2531048, 2531049, 2754703, 2527307 and patents applied for.

HUCK *MANUFACTURING COMPANY*

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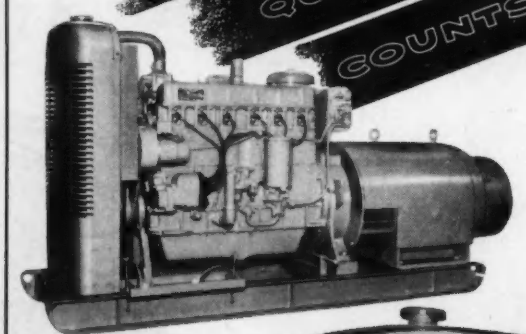
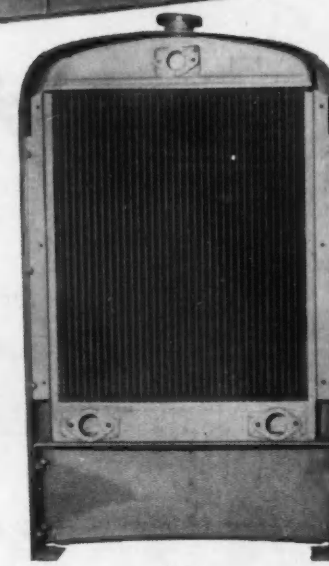
WHERE QUALITY COUNTS



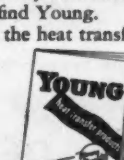
count on *Young* radiators to cool correctly



Whether their service is intended to be continuous or for standby emergency use the engine-generators made by United States Motors Corporation, of Oshkosh, Wis., are known far and wide to be extremely reliable. This reliability is based on years of manufacturing experience plus the use of top-grade purchased components — among them Young Radiators.

Young furnishes both radiator and shell and grill assembly to U.S. Motors for the 60 kw model shown as well as for other models. You'll find Young Radiators on many applications including engines from 2 HP up to installations rated in thousands of horsepower. Tractors, trucks, earthmovers, compressors, oil field equipment — for any heat transfer application *where quality counts* you'll find Young.

Young engineering talent has solved the heat transfer problems of others. How about calling on us to investigate yours? No obligations, of course.



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Heat Transfer Products for Automotive, Aviation and Industrial Applications. Heating, Cooling, Air Conditioning Products for Home and Industry.

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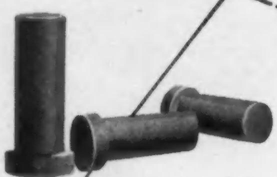

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Precision testing methods provide close control of casting quality

Curtiss-Wright's Metals Processing Division today offers your industry precision castings of critical parts in a wide variety of sizes, and with closely controlled dimensions. For example, in the large casting shown, tolerance is $\pm .030$ over 36" diameter. From its modern, completely equipped foundry in Buffalo, the Division supplies heat, corrosion and abrasion resistant castings from a full range of special-property alloys, including ductile iron... by sand, centrifugal, ceramic or shell processes.

Precision alloying techniques, modern melting controls with spectrometer testing, X-ray control by experienced radiographers – all add up to castings with superior physical and mechanical properties . . . mean better and more dependable products for the critical needs of industry. Qualified design engineering assistance is a part of the comprehensive Metals Processing Division service. Write for details.

77 GRIDER STREET

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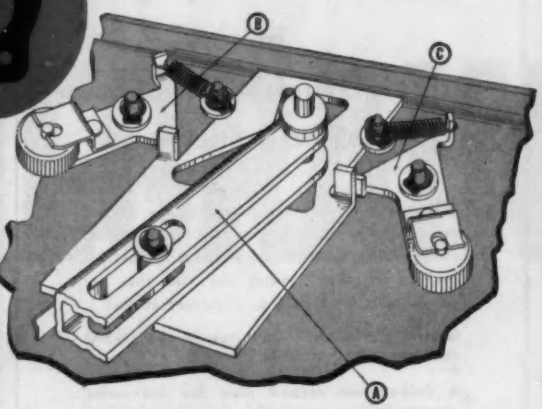
Waldes Truarc grip rings used on die-cast studs eliminate threading, tapping, other costly machining

Mark Simpson Manufacturing Co., Long Island City, N. Y., uses Waldes Truarc series 5555 Grip Rings to secure parts to studs of the zinc die-cast base of its "Masco 500" portable tape recorder.

The rings—which need no grooves—replace nuts, screws, cotter pins and other types of fastening devices which require threading, tapping, drilling and other expensive machining operations. Because a single cracked or broken stud would render the entire cast base useless—and with it, all assembly completed to that point—the rings also eliminate extremely costly rejects.



Pivot Assembly of shift lever (A) is secured by a single Waldes Truarc Grip Ring and washer. Because the washer must be installed over the shift level in a sliding fit, critical tolerances would have to be maintained if a screw or cotter pin were used. The Truarc Grip Ring eliminates that problem: it requires no groove and may be seated over the washer at any point on the stud, automatically compensating for accumulated tolerances in the parts. BRAKE ASSEMBLIES (B and C) use Grip Rings to secure the brake wheel and spring subassemblies. Here again problems of critical tolerances are avoided and expensive rejects eliminated.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types... as many as 97 different sizes within a type... 5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U. S. A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today... let our Truarc engineers help you solve design, assembly and production problems... without obligation.

For precision internal grooving and undercutting... Waldes Truarc Grooving Tool!

WALDES TRUARC® RETAINING RINGS

WALDES KOHINOOR, INC.
47-16 AUSTEL PLACE, L. I. C. 1, N. Y.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N.Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

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City .... *Zone* ..... *State* ....

SA029

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

Quality Control Counts!

Manufacturing growth usually depends on one prime ingredient . . . *performance!* In the field of vinyl resin coated fabrics, ATHOL is proud of their continuing ability to provide consistent, reliable quality in accordance with *exact specifications.*

It is ATHOL'S many years of experience and never-ending pioneering in the coated fabric field, *plus* the technical skill developed from servicing some of the largest users in the country, that has resulted in our present highly expanded production facilities.

Your inquiries are invited.

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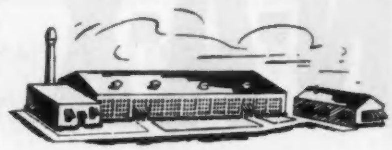

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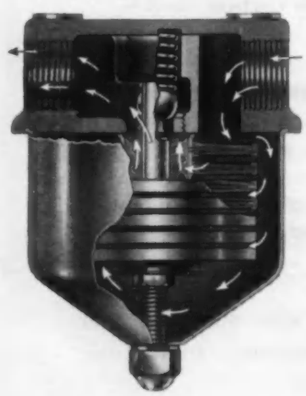
CLEANABLE MICRONIC LIQUID FILTER



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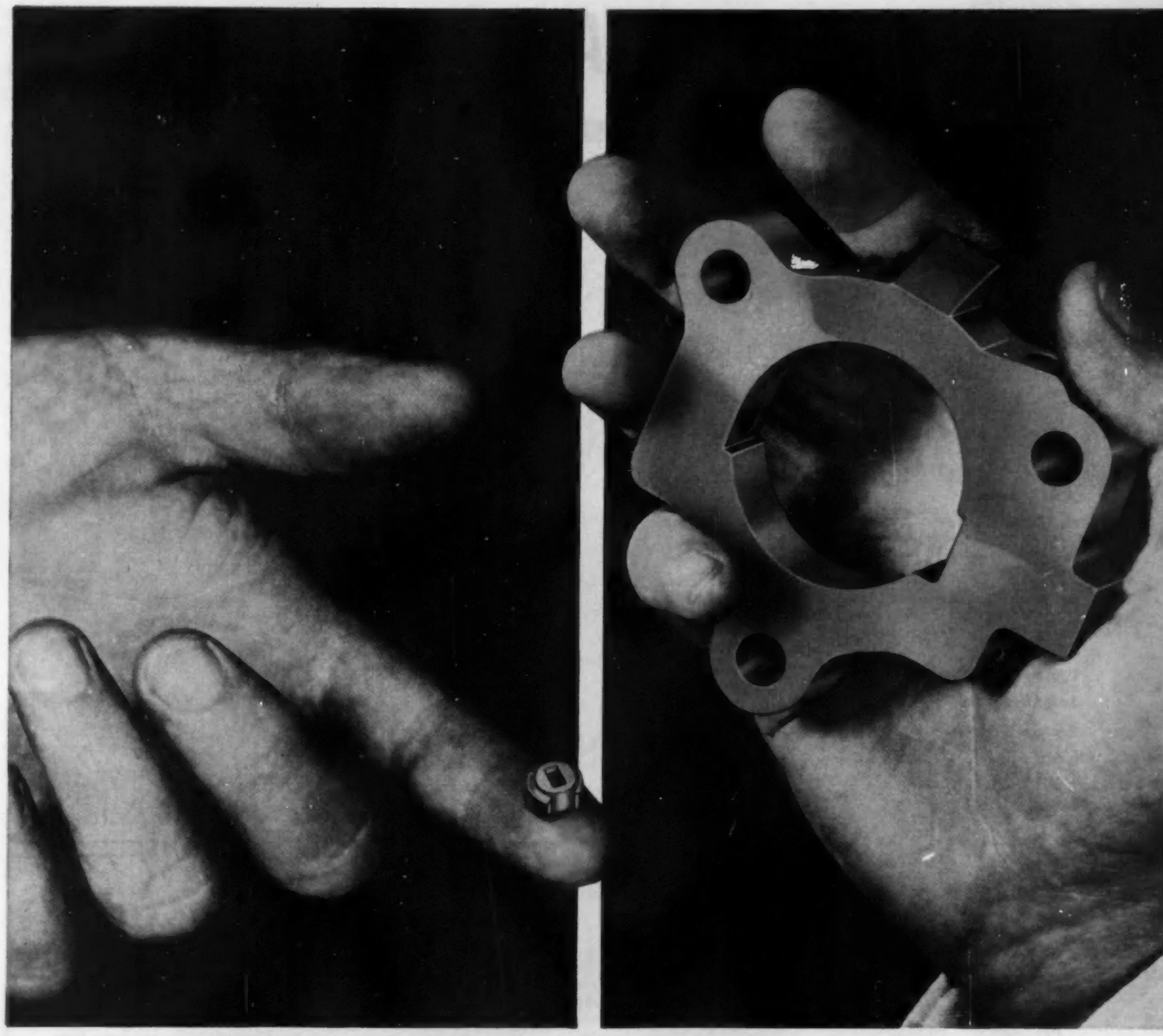
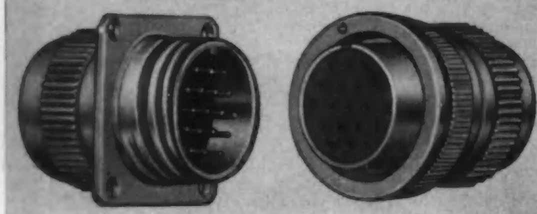


BIG NEWS ABOUT A LITTLE PRODUCT

(ACTUAL SIZE)



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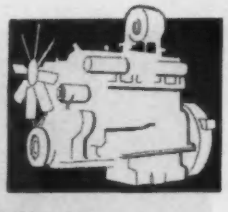

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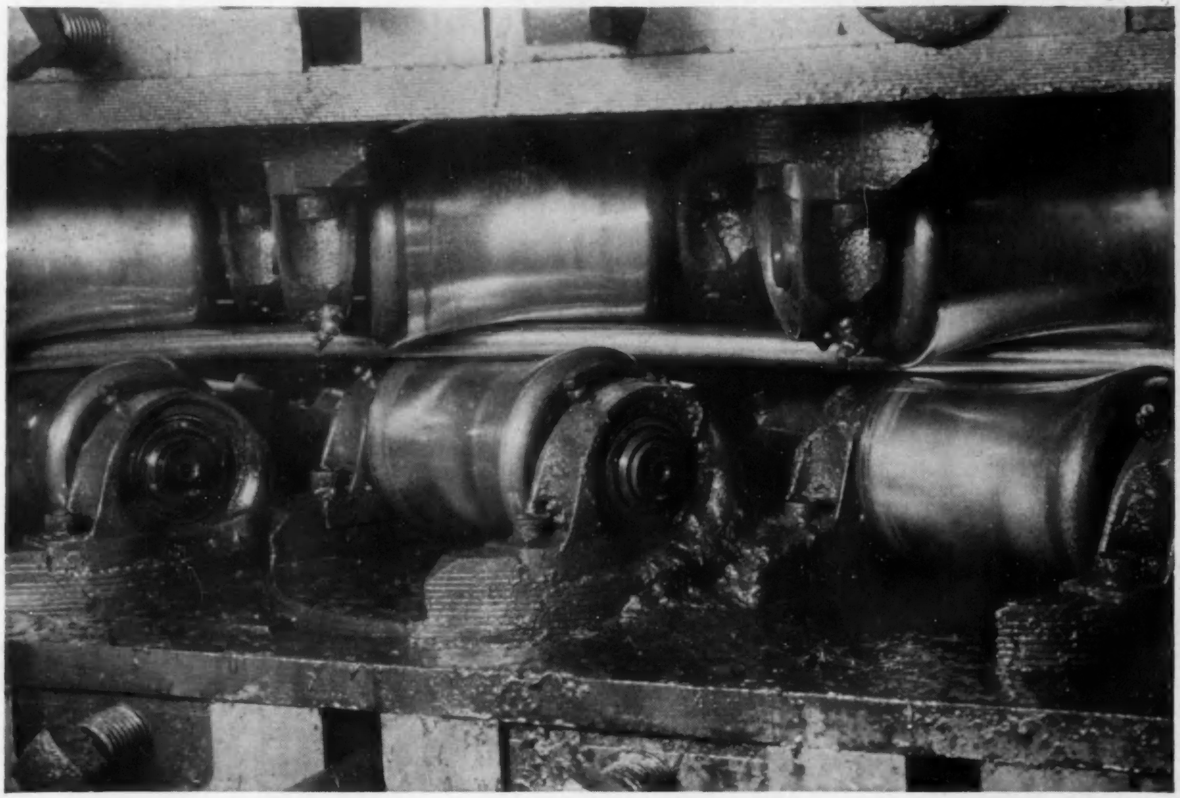

Uses tool steel that outwears others 3 to 1 for its straightener rolls

TO help its customers get the longest possible life out of the rolls used in its small tube straighteners, Mackintosh-Hemphill Division of E. W. Bliss Co. makes them from Graph-Mo® steel.

Graph-Mo contains millions of tiny particles of diamond-hard carbides. As a result, users report it outwears other tool steels on an average of three to one!

Graph-Mo steel also contains free graphite which gives it outstanding anti-friction properties, prevents pick up and scoring. This is a big advantage to users of small Mack-Hemp straighteners because it results in a better surface on the products being processed. What's more it eliminates chrome plating the rolls, which is usually necessary when the straighteners are used for non-ferrous metals such as brass.

Graph-Mo steel gives Mackintosh-Hemphill two other important manufacturing advantages. It saves machining time because it's 30% easier to machine than ordinary tool steels. And it simplifies heat treating because of its uniform response to heat treatment.

Graph-Mo is one of four graphitic tool steels developed by the Timken Company. If you want more information about their use in dies, punches, gages and machine parts, write for the new Timken Graphitic Steel Data Book. The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

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